Water Supply and Irrigation

Crop Protection Exhibition Review

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Editorial Comment

Water—the supreme need

IN THE arid and semi-arid regions of the world the need for artificially-contrived supplies of water is greatest and here are to be found many of the under-developed and backward countries of the world. The lives of the people are subject to the restrictions imposed by an unkind climate, by poverty and by the disproportionate effort required to produce the poor crops which nourish, or rather under-nourish, them. Far too frequently these crops fail and famine stalks the land.

The economy of a country where such conditions obtain is not likely to be such as to provide its people with any appreciable portion of the comforts and conveniences, or the luxuries and amenities, which we look upon as necessities and as the right and expectation of even the poorest citizen.

The hard lot of these people is no worse than it was a thousand years ago, but now there is a significant difference. Communications have improved; the cinema, the radio and newspapers have impressed on these under-privileged peoples that their hard lives are not the common lot in all countries. They hear – generally from trouble-making agitators or from returning students – of the better conditions enjoyed by those in similar occupations in other lands and they begin to wonder. They are discontented; they are envious; and finally they arrive at a state of mind when they are prepared to seize by violence what they cannot obtain peaceably.

It is to the prevention of revolution by destruction that the minds of the governments of these countries are, or should be, turned. The provision of better living conditions for the masses is something that these governments must undertake or be overthrown by a disappointed and hostile electorate. So it is necessary to consider what measures are most likely to give satisfaction.

In these arid countries the very first essential is water. Its very scarcity makes it precious; its absence is the denial of life and where no water is available the land, no matter how fertile it may be, becomes uninhabited desert. It is for this reason that enormous tracts of the earth's surface are unpopulated – lands which could grow food and support millions of colonists and provide adequate food for the hungry, if only water could be made available.

In considering schemes for the provision of water for the irrigation of such barren lands time is an important consideration. For how long will the people be prepared to wait for an improvement in their conditions of living? Will an under-fed people be satisfied with the prospect of an improvement in their circumstances in the distant future? Will the government which implemented a long-term scheme of irrigation, involving the construction of gigantic barrages and dams, still be in power when the scheme is finally completed?

Such political considerations are important when schemes for irrigation are under consideration. In this issue there is an article in which the merits of irrigation by surface waters and by sub-surface waters are compared. According to the author, a scheme for surface irrigation may take a year, three years, five years, even ten years, and during this period ' not one grain of wheat or blade of grass can be grown by irrigation '. Where sub-surface waters are available and are of satisfactory quality, a tube well scheme can be producing revenue even in the first three months, and ' as each new tube well is completed and energised a square kilometre of land can be brought under irrigation '.

Automatic irrigation?

A RECENT American article (S. J. Richards, *Crops and Soils*, 1957, **9**, 8, 9) discusses instrumentation for the control of farm irrigation, *i.e.* the need for ' a simple measuring device that will make irrigation more efficient and crop production more economical '.

It would certainly be pleasant to associate mechanical irrigation with devices that ' ring the bell ' when extra water is needed, but is this really within the realm of practicability? For many decades, scientists have been seeking doubtproof and quick methods of soil testing for major nutrients, but every method presents its problem of interpretation—for different soils the results have differing meanings.

The ability of soils to retain water and to release proportions of this retained moisture to crops likewise varies according to soil type. Also, speedy methods of testing for soil moisture content are just as much based upon approximations as are the speedy tests for nutrients in soils.

Two methods now in use are described: (1) the tensiometer method, which relies upon the suction force developed as moisture is removed from soil in an embedded porous cup, and (2) the measurement of the electrical resistance of embedded porous blocks. Each device measures a property that is affected by the amount of soil moisture in the soil around the embedded portion of the apparatus; therefore readings in the form of ' numbers ' should be related to percentages of soil moisture actually present.

It is a truism of science that an effect, or property, cannot be understood until it can be measured, but this

' law ' belongs more to the world of mechanistic science. There is an older truism for agriculture—that the best manure is the mud on the farmer's own boots. In the same spirit, surely the best method of judging when irrigation is required during crop growth is to be found in the eyes and experience of the farmer? Can devices that seem at best to be approximate in their verdicts, and which require calibration to fit results to the soil type, be better than judging the need for water by crop appearance? It is difficult to believe that farmers cannot estimate the dryness or over-wetness of a soil with reasonable accuracy.

The use of artificial irrigation should be so developed that such intelligence and experience is encouraged, as the development of field instruments which substitute dial readings for personal judgment might perhaps protect the incompetent, but might not be in the best interests of agriculture. It seems likely that the main use of these moisture meters is as instruments of research.

Plastic linings for reservoirs

RESERVOIRS LINED with plastic appear to be the answer to water-supply problems on the new pumice farmlands of the Rotorua-Taupo district, according to a report in the *New Zealand Herald*. Hitherto ponds and reservoirs to store water have been ruled out in such country because of rapid and total loss through seepage. It has now been found possible to excavate a pond and line it with sheet plastic to give an impervious bottom at a quarter of the cost of doing the same job in concrete.

This technique was first tested at Earthquake Flat, near Rotorua, when the Soil Conservation and Rivers Control Council wanted a reservoir built to provide water for a trial it proposed to make on the use of water-carrying aircraft to fight scrub and forest fires (see WORLD CROPS, 9, 1957, 490).

A tank was excavated with a bulldozer to a depth of 6 ft. It was 10 ft. wide and 40 ft. long and its estimated capacity was 13,600 gallons. It was filled with water from fire trucks and was left for two months. Little or no water was lost during this period, and the tank remained full. The lining used was a black polythene film.

The success of this first lined tank encouraged the N.Z. Department of Agriculture to build a lined reservoir in a pumice district that suffers badly from a shortage of water in the summer. Owing to volcanic movements in this area, concrete tanks do not last many years.

The tank was excavated on top of a hill and is to be filled during the winter when water is plentiful. In the summer this water will be reticulated over the farm to supply water to farm stock.

With no natural water supply from streams or creeks available, farmers in the district have to rely largely on deep-well bores, some of them going down 1,000 ft. The rate of flow of these bores is usually slow and so a storage reservoir is essential.

The tank is shaped like a rectangular pan, with side slopes of about 25°, or 2½:1. It is 115 ft. long, 54 ft. wide and will hold 150,000 gallons of water. Its spillway is to be concreted over to prevent erosion.

As it was being constructed, the tank was also consolidated, the final batter being graded by hand. The bottom and sides were rolled with a garden roller to break down any hard or sharp pieces of pumice. Finally, a trench was dug around the perimeter of the tank into which the edge of the plastic liner was laid and anchored down.

The black polythene liner was made up from long strips, 9 ft. wide, heat-welded together and centre-folded in accordion pleats. The plastic was unrolled from a reel along one edge of the reservoir and pulled across to unfold it to form a complete covering over the base and side walls. It took 2½ cwt. of plastic to line the reservoir.

Little work was involved in pulling the liner into place and tucking in the corners. The edges were laid into the trench around the perimeter and then covered with a layer of pumice about 4 in. deep. Then the whole area of the liner was lightly covered with pumice soil to prevent sunlight from damaging the plastic.

The plastic liner costs 8½*d.* a sq. ft., equivalent to between 30*s.* and 35*s.* for each 1,000 gallons of storage. The only other charges were those for bulldozing and labour. The life expectancy of a lined reservoir is likely to be from 10 to 20 years. The polythene film is light enough for the material to be handled easily by two men. It is relatively tough and can withstand considerable tension before tearing.

Plastic-lined reservoirs appear to have a great potential, not only in the pumice country of New Zealand, but also on pervious soils in other parts of the world where seepage losses are a problem in water storage.

Camphor and vanilla

TWO NEW research schemes have recently been approved by the Indian Council of Agricultural Research for the coming financial year and these are expected to lead to the increased cultivation of camphor and vanilla. The schemes, which will cost Rs. 132,630, or about £10,000, will be carried out at Wynad in Kerala State, South India, where there is already a plantation of camphor which is claimed to be one of the largest of its kind in the world. The camphor scheme will aim at studying the manurial requirements of the trees for increasing yields and the camphor oil content. Exploratory trials have already shown that vanilla can be successfully grown at Wynad and the aim of that research scheme will be to determine the conditions in which vanilla can be cultivated in South India.

Co-operative experiments

IN CONNECTION with the item 'Research or Demonstrations?' (WORLD CROPS, 1957, **9**, 437) a correspondent has sent us an abstract from the Report on the Indian Council of Agricultural Research made by Sir E. John Russell to the Government of India in 1937.

We quote:

'Fertiliser and manurial trials . . . should not, however, be confined to the station, but some simplified form should be tried as widely as practicable on cultivators' fields and the chemist should receive samples of the soils so that he may see if any relation exists between the field results and the data given by the recognised methods of soil analysis. It would be of considerable advantage if this work could be done in association with the large fertiliser organisations who have already collected considerable information on the subject and who have a wide experience of the types of experiment possible'.

It is satisfactory to note that the co-operative method of experimentation is working in India today. The smallholders co-operating in the coconut, rice and tapioca schemes of Potascheme could not have purchased fertilisers unless and until they had the enhanced crops to provide the cash.

'Peaks on peaks arise'

THE WORLD HEALTH ORGANISATION celebrated its tenth anniversary in April and its successes during the short period of its existence have been considerable. Hundreds of research centres have been established; millions of health workers trained; hospitals and health centres have been built in towns and in remote areas; and voluntary organisations have been formed to fight disease through joint action. Many killing diseases, such as smallpox, cholera, yellow fever, malaria and tuberculosis, have been brought under control to such a degree that the Organisation speaks modestly of the 'expectation of their eradication'.

Truly the results of the advances of medical science during the past 25 years have been formidable, but, as in other fields of work, such advances bring a host of new problems. The latest FAO Yearbook shows that world population rose from 2,136 millions to 2,691 millions from 1937 to 1955. Thus, world population has increased by one-quarter in slightly less than 20 years, and this in spite of the many millions who died, either directly or indirectly, as a result of the second world war and the minor wars that have followed.

The question naturally arises - how much longer can the increase in agricultural production keep pace with this terrifying increase in world population? It is little use pointing to the achievements of certain countries whilst the situation becomes increasingly acute in others, where as a result of the magnificent work of medical science population increases are now getting out of hand.

In his Armstrong address to the Royal Society of Arts, Mr. N. W. Pirie recently made an impassioned plea for large-scale research on entirely new foods, such as protein or carbohydrate extracts from plant foliage. He said that hardly any attention was being given to biochemical research for the better utilisation of what is grown or what could be grown. We could, he said, search the plant kingdom for species that will grow exuberantly and which have been neglected because the techniques of primitive man were not adequate for the separation of useful food components. This search would be followed, when necessary, by conversion processes using micro-organisms, which operate much more efficiently than farm animals. The accepted role of the farm animal as a converter of plant materials into protein concentrates he criticised as wasteful. In other words, the steak, already a most expensive luxury in many countries, might well become a thing of the past if the uncontrolled increase in world population continues at the present rate.

There are admittedly still new areas of land to be harnessed for cropping and there is enormous room for the increased use of fertilisers, but Mr. Pirie made the important point that fertilisers will only have their full beneficial effect when they become more amply available in South and East Asia, where food shortage is most acute. The deduction from this is that there is room for aid on a massive scale to ensure the increased use of fertilisers.

Another tenth anniversary

THE BRITISH FERTILISER SOCIETY has recently celebrated its tenth birthday. Though fostered by the Fertiliser Manufacturers' Association, the Society has lived independently as all scientific organisations should. Certainly it has not become the platform of commercial interests or propaganda and from the beginning its Proceedings have established themselves as genuine contributions to technical literature.

Today the Society has 485 members compared with 250 in 1949, and membership is steadily growing. Overseas membership is also increasing and the Proceedings are now being sent to 35 Commonwealth and foreign countries, including the U.S.S.R. and China. One of the primary objectives was to bring together chemists and engineers in the fertiliser industry, providing a forum for the exchange of views. This has been achieved to an extent beyond all original hopes.

There has perhaps so far been a decided bias towards subjects concerned with manufacture. In the next phase of the Society's life, however, greater attention to the science of fertiliser use can be expected. Although world fertiliser use has expanded so robustly since 1939, the major problems of development are still those of use; problems of production, even if sometimes troublesome in detail, are minor by comparison. If in the next ten years the agronomist and the agricultural economist make more frequent appearances on the Society's platform its success will be consolidated. The impression that it exists mainly to stimulate manufacturing technology is wrong. Anyone

associated with the production or use or application of fertilisers may join it and well-known agricultural scientists from independent research centres have already served on its Council, notably the late Dr. E. M. Crowther, of Rothamsted, who also served as president.

The Fertiliser Society is unique in the world. In the U.S.A. the industry has formed a Round Table for open discussions, but so far this has not also become a society like the British one, which within ten years has acquired a world-wide reputation.

Atomics in South Africa

WE HAVE learned that at the Cape Western Province Fruit Research Station research workers have designed and built a neutron soil moisture meter. At present this is to be regarded only as an experimental device, but we understand that extensive field tests are now being carried out. Its purpose is to measure the soil moisture in less than a minute without disturbing or removing the soil for analysis, so that it will be possible to repeat the determination at a later date in the same place.

The probe unit of the meter contains a radium-beryllium source emitting fast neutrons. This source is placed on the wet soil and the speed of the fast neutrons is slowed down as a result of successive collisions with the water in the soil. By counting the number of slow neutrons produced, it is said to be possible to determine the soil moisture content, because the number of slow neutrons is proportional to the moisture content of the soil. The unit is connected to an electronic scale, where the pulses from the unit are registered.

With the aid of this unit it will be possible to find out how fast water is lost by evaporation and transpiration and at what rate it penetrates in the soil, so that farmers with a limited supply of water will be able to use the instrument to determine the moisture content and irrigation water can be applied exactly when it is required. In other words, they will be able to utilise their irrigation water much more effectively and economically than in the past and so increase production and save water.

Experts for export

SOME EIGHT years ago the correspondence columns of *The Times* contained a proposal that there should be set up in this country, with official backing, a permanent cadre of expert personnel who could go abroad and undertake advisory work when demands for this sort of help were received from overseas governments and other agencies.

Papers on the subject passed between departments, and as far as Colonial Office responsibilities are concerned, reached the stage of publication in a White Paper printed in May 1956. But little else has come of the proposal.

Over the last decade the sources of supply of technical 'know-how' have been numerous. It is bought in the form of the services of professional consultancy; supplied through the FAO or other U.N. specialised agencies or through the Colombo Plan, or it is given on a country-to-country basis by such organisations as the American 'Point Four' administration, the Rockefeller and Ford Foundations and the Middle East Development Division of the British Foreign Office.

The motives for providing much of this advice were, in the early stages, humanitarian and political. But advice-giving has now spread into the sphere of commerce and trade. From being something which was bought separately from the goods or plant orders, it is becoming increasingly something which the overseas buyer expects to find included in his purchase, like a pretty packing or a set of instructions, according to Mr. A. S. Windett in an article in 'Speaking for Britain'.

East Africa's arid areas

IT DOES not appear that the twin problems of soil erosion and water conservation can be solved economically in those areas where there is serious over-population, where the rainfall is erratic and takes the form of violent storms of short duration, and where the soil is of a highly erodible character. Such a combination of circumstances will lead to over-cropping, sheet erosion, gullying, the silting-up of streams, and the gradual development of desert conditions – the typical pattern of a dying civilisation.

Dr. E. W. Russell, Director of the East Africa Agriculture and Forestry Research Organisation, recently told the UNESCO Conference in Karachi of his experiences in connection with rain storage in semi-arid areas. He said that over most of East Africa, where the soil was not too erodible and the population not too high, economic methods could be found which would ensure that the bulk of the rain falling entered the soil and was available to the crops.

The problems of water conservation, however, are not so easily solved in some parts of East Africa and he instanced some areas where there are still no economically feasible methods for reducing soil erosion – one region in the Central Province of Tanganyika with a high human and cattle population suffers from irregular rainfall, very heavy storms and has a very erodible sandy soil. In consequence of over-grazing and over-cropping the land is being eroded and streams that used to run for many months of the year have now become rivers of sand, up to a mile wide, which run intermittently with muddy water for only a few hours after each storm.

Experts who considered the problem in 1956 made certain recommendations for controlling the erosion, but the measures they suggested could only be applied in one small area and were not suitable for this vast semi-arid region.

The Rt. Hon. Tom Williams, P.C., LL.D., M.P., speaking at the opening of the Crop Protection and Pest Control Exhibition

Seen at the Show

Review of the Crop Protection and Pest Control Exhibition

VISITORS from all parts of the world participated in the coming-of-age of the new science of crop protection and pest control at the first international exhibition of its kind which was held last month in London under the sponsorship of WORLD CROPS. Although farmers and horticulturists, scientists and economists have for centuries deplored the enormous wastage of the world's food supplies, due to the depredations caused by animals, birds, insects and other hostile agents, only now can it be said that man is at last coming to grips with the forces of destruction.

There is no doubt that an exhibition of this kind was long overdue and the view was freely expressed that it should be made an annual event. A marked feature of the exhibition was the serious interest taken by all visitors and the excellence of the presentations of the individual firms participating, who reported that good business had resulted.

The Rt. Hon. Tom Williams, P.C., LL.D., M.P., who was introduced by Mr. Leonard Hill, in declaring the Exhibition open, said:

'. . . I have been convinced for a long time that we should take the long as well as the short view of the dual problem of world food supplies and the rapidly growing world population. For if, as the statisticians warn us, the 2,700 million population today may be 4,000 millions before the end of this century, we shall need to win both the battle of scientific food production and its protection and conservation, if the people are to be reasonably fed.

Nor must we allow any temporary surplus of some foodstuffs, here or there, to obscure the fact that 50% of the world's population is still grossly underfed, and that periodic famines are still possible in some countries.

Fortunately, science has made a wonderful contribution to food production during the past few years, and similarly spectacular advances have been made by those scientists who are concerned with the protection and conservation of crops. But we need more and more research, and particularly earlier and better application of its results, for the losses caused by pests to crops are staggering and should be a major concern of every Government, farmer, horticulturist and gardener. . . .'

Concluding, Mr. Williams said that there was no form of investment in agriculture which would give such good returns as expenditure on the control of pests.

The following account gives the highlights of the Exhibition:

AAgrunol Chemical Works Ltd. showed a range of their pesticides, including fungicides, seed disinfectants, insecticides and weed controllers. This Dutch firm has its own chemical and biological laboratories, where much research work and numerous field trials are conducted. In addition, all their products are examined by the phytopathological service at Wageningen before they are put on the market. The company makes an extensive range of products for agriculture and horticulture as well as for fruit and bulb culture.

African Pyrethrum Technical Information Centre Ltd. The story of pyrethrum from the growing of the flower to the varied use of insecticides based on it was illustrated.

Apart from its quick paralysing effect on insects, known as 'knockdown', pyrethrum is extremely useful because of its non-toxic properties which enable it to be used where foodstuffs are handled or stored without fear of harm to humans or animals. No significant case of resistance has been reported where pyrethrum-based insecticides have been used, in contrast with many synthetic insecticides.

Agricola Plant Chemicals Ltd. The main feature of this exhibit was the Agricola electroduster; two models were shown: the 'Baby' Mk. IV, which is a two-men apparatus designed so that it can also be mounted on transport, and the 'Papoose' knapsack-type machine. The electroduster imparts a positive electric charge to the dust on ejection, thus precipitating the dust on all sides of the plant and, because the plant is negative, achieving a high degree of adherence. Electrodusts for use with this machine are also manufactured by the company.

Airspray (Colchester) Ltd. staged a display based on their work as specialists in the aerial application of liquid and dust pesticides, fungicides and fertilisers.

E. Allman & Co. Ltd. A selection of sprayers and farming equipment manufactured by this company was exhibited. The 'Sprayall 100', a high- or low-volume general-purpose sprayer, is designed for the large-scale potato grower; it can be supplied for cereal crops and is also particularly suitable for cotton spraying. The Model 30, which was also displayed, is an easy-to-handle portable sprayer on four wheels suitable for spraying fruit trees, lawns, pathways, verge-sides and railway tracks. Also shown was the 'Speedispray', a low- or medium/low-volume sprayer.

Atlas Copco (Great Britain) Ltd. Compressed-air equipment developed for the application of aerosols and other liquid agricultural products as well as equipment for small property maintenance was shown on this stand.

The Atlas Copco PE3ET compressor and L22 spray gun are especially suitable for the spraying of aerosols in greenhouses. The long length of hose makes it possible for the compressor to be left outside

Electrically- and petrol-driven compressors with piston displacements of from 2.5 to 9 c.f.m. were displayed with specially matched spray guns and containers for the different types of materials. These can be converted from horticultural to building maintenance purposes by changing the nozzles and air caps on the spray guns. Also on view was the Atlas Copco moisture sprayer, which automatically controls the humidity in a greenhouse.

The PE3ET compressor and L22 spray gun have been designed for the very fine atomisation of aerosols in greenhouses.

A. B. Blanch & Co. Ltd. The Blanch banger bird scarer, which protects crops from the ravages of vermin, birds and wild animals, was shown by this company. Operated by acetylene gas produced from carbide and water, the loud detonation will scare birds and animal pests from an area of approximately 50 acres. The rate of detonation is controlled by the thickness of the wick and a time clock attachment can be set to turn the banger off and on once in every 24 hours for eight days. The machine can thus be set to stop detonating at dusk and to restart firing at dawn.

Brinkhoff & Jahn Ltd. An interesting exhibit on the stand of this Swiss firm was the hand-operated rotary powder duster, known as the 'Stroco'. The powder is rubbed through a fine sieve by rotating nylon brushes. These can be adjusted by means of a lever so that the dosage can be regulated as desired, and any powder, irrespective of density, specific gravity etc., can be used. Knapsack sprayers on display included the 'Friulana', which has a 16-litre capacity copper tank, and the 'Super Friulana', with an 18-litre capacity brass tank, which gives doubled output when two spray rods are used. Both are equipped with a patented double piston, affording easier and less tiresome operation. Sipi products seen at this stand included a number of hand-operated pumps with spray rods and nozzles designed mainly for insecticide spraying in the garden. The U.K. representatives of Brinkhoff & Jahn Ltd. are M. Fulder & Co. Ltd.

The British Ratin Group of Companies. The products and services of five member companies dealing with crop protection and pest control were exhibited by this Group. The R.S.M. mobile sprayer shown in an appropriate orchard setting formed the centrepiece of the display. Rentokil Ltd. were represented by the 'Rentokil' woodworm and termite exterminator, 'Rentodye', a range of insecticidal wood dyes, and 'Rentopol', the silicone cream or wax which conveys important insecticidal properties to polished furniture and floors. A new aerosol, 'Rentofab', contains synergised pyrethrum and can be used against all flying insects; it is also a mothproofer and deals effectively with carpet beetles. Woodworm and Dry Rot Control Ltd. drew attention to their timber treatments, which carry a 20-year guarantee. Specimens of the very wide range of insects and rodents which are controlled under service contracts were shown by Disinfestation Ltd. Fumigation in its application to the infestation of food was displayed by Fumigation Services Ltd.

The new tractor-mounted 'Sprayall 100' fitted with Allman atomiser nozzles, which give a particularly good performance when emulsion- or suspension-type spray materials are used

British Wood Preserving Association. This display dealt with the insects and fungi which attack timber and also with the three main types of wood preservatives, their principal uses and methods of application. Information was given on the preservative, curative and remedial treatments of timber and on the spraying of newly-felled timber overseas against ambrosia beetle attack.

Chase Protected Cultivation Ltd. The foliar nutrient and soil conditioner, 'Sea-Magic', was prominently displayed. This product consists of 80% carefully chosen seaweeds with the tissues of a number of land plants added to give 'balance' and is thus entirely organic. It contains all the seven essential trace elements and will make up any trace element deficiency without upsetting the overall balance. Its plant hormone content ensures a strong and vigorous root system. 'Sea-Magic' has been used with success in such varied crops as tea, cocoa, bananas, cereals, grass and citrus.

Church Road Motors (Southend-on-Sea) Ltd. As world concessionaires of the EXID 'Thunderbird' bird and pest scarer, this company exhibited several complete cannons to demonstrate the ease with which they can be carried, with and without the 'Early-bird' automatic starter. A sectional model which was on view showed the construction of the model and the simplicity of the working parts.

Colonial Pesticides Research Committee illustrated the work of their research stations at Arusha in Tanganyika and at Porton, U.K.

At Arusha subjects at present being studied include the aerial application of insecticides for control of tsetse fly, house spraying for the most efficient control of mosquitoes, the control of the *Pseudotheraptus* pest of coconuts, scrub control by herbicides and the most efficient control of the black pod disease of cocoa. At Porton the unit is studying the behaviour of insecticide droplets, the sorption of insecticides by building materials, and also working on the assessment of new insecticides and formulations and the development of air-borne spraying systems for special purposes.

Commonwealth Agricultural Bureaux illustrated its work by a display of its abstract journals and publications. Information from a large number of journals in the subject in all languages is collected, indexed and disseminated through these publications to scientists and research workers in agriculture, animal health and forestry throughout the Commonwealth and increasingly further afield. The institutes also have their special function of identification, and the Institute of Biological Control undertakes its special work of collection of suitable predators and parasites and shipping them where they are needed to control pests and epidemics.

The Chase Protected Cultivation Ltd. stand. On the left is Mr. Leonard Hill, Chairman of the Leonard Hill Technical Group

'Friulana' knapsack sprayer with a double piston for easier operation

Cooper, Pegler & Co. Ltd. showed a full range of spraying and dusting machinery for growers of large and small crops of every type. The 'Hydra', 'Lancet' and 'Fog' hand-operated machines for use on small acreages of coffee, cocoa, cotton, rice etc. were displayed, as well as the 'Eclair' knapsack sprayer and high-pressure power sprayers. A wide variety of dusting apparatus included the small bellows-type Models 'U', 'M' and 'O', the 'Torpille' knapsack bellows duster, and the 'Rotver' dust gun. The 'Mapic' D2T soil steriliser and the 'Mapic' 44, for the application of fertilisers to the roots of fruit trees, were also shown.

Crown Pump Manufacturing Co. Ltd. exhibited the rotary vane 'V'-type agricultural insecticide spraying pumps with p.t.-o. coupling and the rotary gear 'A'-type agricultural spraying pumps as well as water pumps, centrifugal pumps and accessories, such as boom filters, relief valves, couplings, pulleys and sprockets.

D.S.I.R. The part played by the scientist in the protection of foodstuffs was demonstrated on this stand, which highlighted three main groups of current research work – storage, biology and control – and included several actual examples of infestation.

One such example was a bird's nest, shown to emphasise how they often harbour food pests. Nests should be destroyed as soon as the birds have left, and all openings in a building blocked to prevent others entering.

Good storage of products is an essential requirement and the cardinal points were demonstrated.

Insects and mites can form permanent populations in spillage in warehouses, factories and ships' holds, where they can infest previously uncontaminated foodstuffs. This threat can be greatly reduced by the proper

The Rt. Hon. Tom Williams and Mr. W. G. Norris with Mrs. Mary Ibrahim who distributed pyre hrum flower button holes

design of buildings, by orderly stacking and by good hygiene, but chemical control methods have to be used once a product or a building has become thoroughly infested.

Another exhibit was a grain moisture meter, developed by scientists at the Pest Infestation Laboratory. It can be ' spiked ' into a sack of grain and gives an immediate reading.

The Dorman Sprayer Co. Ltd. The main feature on this stand was the Dorman ultra-low-pressure system of no-drift spraying. It can be applied to all Dorman crop sprayers and practically eliminates danger to neighbouring crops through wind drift. A number of machines for use on ground crops, in vineyards and in citrus and olive plantations were shown. These machines all have corrosion-resistant tanks, three-stage filtration, automatic no-drip device and can be adapted to suit particular conditions.

Eclipse Spraying Co. Ltd. exhibited their range of hand-operated spraying outfits and accessories for agricultural and horticultural purposes, hygienic and anti-malarial spraying.

Exhibition Bookshop. Works on agricultural and horticultural subjects published by Leonard Hill (Books) Ltd. were available at this stand for examination and purchase. These included: *Crop Protection*, by G. J. Rose, B.SC.; *The Manure & Fertilizer Notebook*, by John Stewart Remington and Wilfrid Francis; *Modern Coffee Production*, by A. E. Haarer, F.L.S., DIP.HORT.R.H.S.; *Modern Farm Dairy Equipment*, by R. T. Needham, A.INST.R.; *A Dictionary of Dairying*, by J. G. Davis, D.SC., PH.D., F.R.I.C.; *Egyptian Cotton*, by C. H. Brown, B.SC.; *Agriculture of the Sugar Cane*, by A. C. Barnes, C.M.G., B.SC., F.R.I.C., A.M.I.CHEM.E.; and two handbooks published by the company in conjunction with FAO. *Efficient Use of Fertilizers*, edited by V. Ignatieff, and *Improving the World's Grasslands*, edited by A. T. Semple.

Two new series on major world crops and ancillary subjects are planned: World Crop Books and Plant Science Monographs. These will be of particular interest to agriculturists and horticulturists and the first titles in these series will appear towards the end of 1958.

The Four Oaks Spraying Machine Co. Ltd. displayed their range of mechanised spraying equipment, consisting of three models with capacities of 6-, 15- and 25-gal. respectively. The 6- and 15-gal. capacity machines, which are suitable for greenhouses, fruit trees, roses and row-crop work, can be handled and operated by one person. They are powered by Villiers 2-stroke engines, and the special spray bar is fitted with five nozzles on the smaller capacity machine and seven nozzles on the 15-gal. model. The ' Spraymobile ' has a 25-gal. capacity, is self-propelled and controlled by a 3-speed gearbox. Also displayed were the ' Four Oaks ' knapsack machines for small-scale application of fertilisers, insecticides and selective weedkillers.

W. T. French & Sons Ltd. Shown for the first time at the Exhibition were two new manually-operated pneumatic sprayers, the design of which was based on the specification laid down by WHO. The W/SS model is made of stainless steel, electrically seam welded, and the W/MS model, also electrically seam welded, of steel finished with a special plastic resin coating. Both models are available in two sizes, giving a working capacity of either 2 or 3 B.I. gal. The type of spray produced is of a cone pattern. The plastic resin coat used in the finish of the W/MS model has proved under laboratory tests and in actual use to resist most chemicals, including copper compounds of various kinds.

A wide range of knapsack and pneumatic sprayers of varying capacities was also on display, including the No. 155, much in use in West Africa for cocoa spraying.

An exhibit of special interest to the gardener was a new featherweight sprayer, the ' Easispray ', which has a transparent tubular container holding 3 pt., and operated by gently pressing the foot of the sprayer on the ground.

Gennar Engineering featured the CFM/100 ' Mini-Compressor ' and accessories, the agricultural applications of which include the spraying of insecticides and protective fluids, the fumigation and disinfestation of poultry houses and farm buildings and the inflation of farm equipment tyres etc. The latest accessory for the ' Mini-Compressor ' is the TJ 2-gal. canister, which will hold 2 gal. of insecticide, limewash, creosote, deodorant etc., can be charged to 80 lb./sq. in. pressure with the ' Mini-Compressor ' CFM/100/G, disconnected, and carried to the crops or fencing for spraying.

C. F. Gerhardt Ltd. displayed ' Dethmor Warfarin ', a concentrated rodenticide which is also manufactured as a ready-to-use bait, ' Dethmor Plusbait ' and, for use in sewers, 'Sewarin'. Also shown were 'Wormex', for the treatment of worms in pigs, poultry and horses, and ' Thram ' for the prevention of feather pecking and cannibalism in poultry.

Hill-Barnes (Pumps) Ltd. showed a new range of self-priming pumps which they make under licence to the design of the Barnes Manufacturing Co., U.S.A. The Barnes range includes

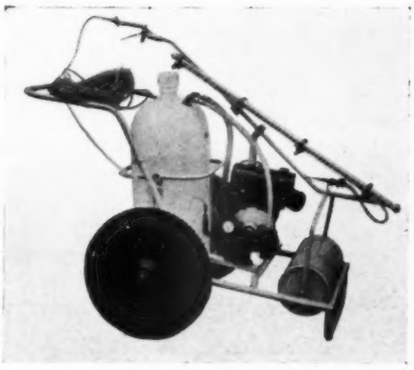
standard and self-priming pumps and domestic water systems capable of lifting water from 200-ft. deep wells aided by patented ejectors.

The principal advantage claimed for the design is that the pump will prime down to 25 ft. suction lift with as little as one-third of the normal water level in the pump body.

The pumps are available in sizes from $\frac{3}{4}$-in. to 6-in. diameter hose connections, with discharges from 1,000 to 90,000 gal. per hour, and can be employed with heads up to 400 ft. Each size will handle solids up to 25% of the flow, with diameters up to one-quarter that of the suction connection.

Kent Engineering and Foundry Ltd. Two machines from their wide range of air-assisted sprayers were displayed by Kent Engineering and Foundry Ltd., the ' Motoblo ', available either as a mistblower or a combined mistblower and duster, is powered by a $3\frac{1}{2}$-h.p. engine giving a large volume of high-speed air which breaks up and carries the spray or dust to cover high trees, bushes or ground crops. This machine has been used for almost every known crop throughout the world, often with unskilled labour and under the most arduous conditions. The ' Conomist ' has a greater capacity, but employs a similar principle of mistblowing. The tractor-mounted ' Conomist ' is suitable for medium-large tractors and is mounted on the 3-point linkage. Eight, four, or single mist outlets make it a suitable machine for chemical application in any crop through which the tractor can pass.

Spraying apples with the Kiekens Type 25 shoulder-mounted mistblower, which weighs only 27 lb.



The new Kestrel power sprayer, showing the detachable lightweight roller

Kestrel Engineering Co. Ltd. A newcomer to the Kestrel range of spraying and dusting machines was exhibited – a power sprayer for the application of weedkillers, fertilisers, insecticides etc. This model incorporates a detachable lightweight roller boom for golf and bowling greens and all fine turf. The capacity of the container is 13 gal. and this and the delivery tubes are in polythene, thus ensuring that there is no corrosion.

Other exhibits included a power-operated dusting machine with a hopper capacity of 60 lb., knapsack sprayers and dusters of varying capacities, telescopic lances and all sprayer accessories.

Kiekens Whirlwind (London) Ltd. exhibited their complete range of low-volume shoulder-mounted mist and powder blowers designed for use in orchards, nurseries, under glass and in tea, cotton, tobacco, coffee, citrus and banana plantations. These are available as a mistblower, powderblower or as combined equipment for both spraying and dusting. Type 25 weighs only 27 lb. and Type 75, 38 lb. (see WORLD CROPS, 1958, **10**, 192, for further information).

Chas. P. Kinnell & Co. Ltd. displayed equipment illustrating the importance of irrigation in crop protection. This included oscillating and hand-controlled portable quick-coupling spraylines for use in watering market gardens and glasshouse crops and pastureland; oscillator-nutrient

The new Motoblo ' Combi ', which will apply dusts or liquids using the same tank, here seen dusting in strawberries

pumps for injecting saturated solutions of chemical fertiliser into spraylines; cluster-head distributor spraylines for glasshouse irrigation, damping of fruit blossoms and for flooding; and rotary spray heads for use with portable mains to water fruit orchards, market gardens, farm crops and pastures.

Leek Chemicals Ltd. were exhibiting the selective weedkillers of Sir T. & A. Wardle Ltd. These included CMPP, which can be applied at high or low pressure for the control of cleavers, chickweed and all the weeds controlled by MCPA and 2,4-D, which were also exhibited; MCPA, supplied in the form of free acid (with formulation details) in three grades; and DNOC, which is being sold in the U.K. for the 14th consecutive year, a free-flowing chemical which does not need a plastic bag and does not settle appreciably except after long periods.

Lunevale Products Ltd. featured agricultural and horticultural insecticides, fungicides and allied products in their display. Of particular interest to fruit growers were the Lunevale venturicide designed for the control of apple and pear scab, and incorporating phenyl mercury chloride as the active ingredient; Lunevale mercurated lead arsenate, a dual-purpose spray for the control of both chewing insects and apple and pear scab; and the mercurated winter fungicide for application during the dormant period to minimise brown rot and canker and to control over-wintering scab spores.

C. B. McAllan (Engineers) Ltd. McAllan hooded flame guns and machines for weed clearance, sterilisation of soil and eradication of pests and disease spores were shown. These burn paraffin only, 1 gal. lasting approximately one hour, and they are so simple in operation that unskilled native labour can be employed.

Also shown was the McAllan turbo heater and air circulator, which is designed for the domestic gardener, but can also be used by commercial growers. This new form of greenhouse heating is also designed to give cool air circulation in summer to reduce temperature and humidity, the changeover being operated by a simple tumbler switch.

Metallurgical Chemists Ltd., who specialise in custom formulating and private brand work and manufacture agricultural crop protection chemicals for the trade, were showing samples of these chemicals, including copper oxychloride in various formulations; cuprous oxide; Agricola electrodusts; Zineb; 'Coxyzin' (based on both copper oxychloride and Zineb); MCPA; 2,4-D; 2,4,5-T, sodium (potassium) arsenate, lead arsenate, malathion, lindane, aldrin, dieldrin and DDT.

Photo: Crown copyright

The Fenn vermin trap. This is one of a selection of new humane traps for rabbits shown by the Ministry of Agriculture

Micron Sprayers Ltd. showed for the first time at an international exhibition their latest machine, the 'Micron Twin'. This is a concentrate sprayer which has been designed at the request of fruit, hop, vine and coffee growers who require a very powerful sprayer for automatic spraying. It can be attached to the hydraulic lift of a tractor and driven by the p.t.-o. The additional power of the 'Micron Twin' has enabled the makers for the first time to abandon the independent engine on their machines; the 'Micron Twin' will spray between 1 and 8 gal. of total liquid to the acre.

The other machine exhibited was the lightweight trolley - mounted version of the 'Micronette' sprayer. This ultra-low-volume sprayer is for the application of low volumes of spray liquid per acre to such crops as bananas, cocoa etc. and is suitable for use on very rough terrain.

Reader Service

Readers may obtain further information on the products of any specified exhibitor by applying to:

Reader Service,
World Crops,
Leonard Hill House,
Eden Street, London, N.W.1,
England

Ministry of Agriculture, Fisheries and Food. Besides exhibiting a selection of their many publications, covering fruit, market gardening, buildings and equipment, pests and diseases, farm business, poultry and livestock, on one stand, the Ministry also had four other stands with static and live exhibits. One illustrated the depredations of the rabbit which formerly cost the nation many millions of pounds a year and is now under control. Unfortunately this pest is again increasing and effective control can only be maintained if all occupiers combine to keep their lands free from these pests. On this stand were shown the new humane traps which have recently been approved as one of the means of eliminating these pests.

On another stand there were live exhibits of the insects that attack stored grain and specimens showing the type of damage that they do; clean and hygienic storage and fumigation were recommended to prevent further losses.

Pechiney-Progil S.A. This French company staged an exhibit based on the chemical and agronomic research and the industrial means which it has used in the service of agriculture and crop protection. Two recently developed specialities were shown: 'Cuprosan', a fungicide for the treatment of vine mildew, potato blight and sugar-beet cercosporiose; and 'Herbogil' cream, a weedkiller for use on cereals and alfalfa.

Edgar Percival Aircraft Ltd. made the EP9 agricultural aircraft the subject of their interesting display. Models of the complete aircraft were shown with photographs to illustrate its various roles. Parts of the aircraft were also displayed and these included spray booms complete with spray nozzles; wind-driven pump, strainer and operating valve; and also the combined hopper-tank, which is lined with fibreglass.

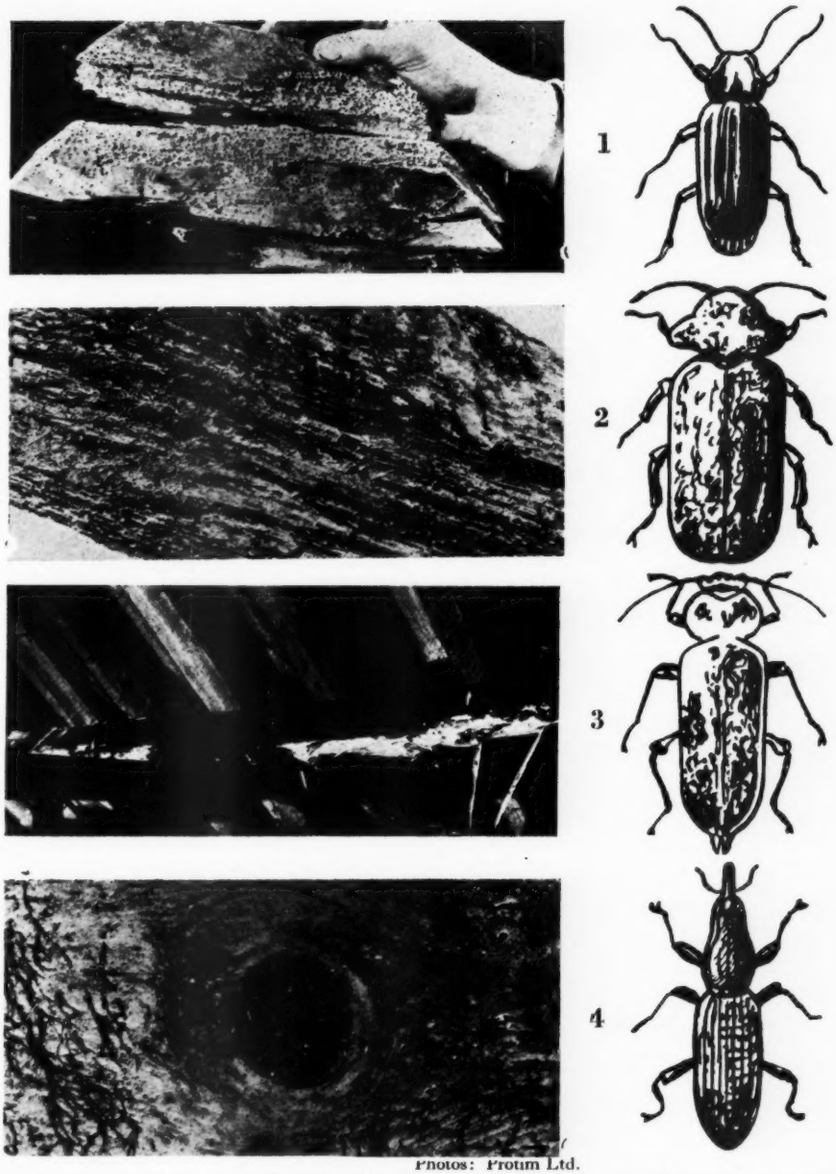
N. V. Philips-Roxane showed their acaricide, 'Tedion V-18', for use against spider mite, a constant threat to practically all kinds of crops and particularly to fruit, vegetables, vine, cotton, citrus and hops. 'Tedion V-18' is effective at the egg, larvae and nymph stages, and its long-lasting effect kills eggs deposited after application. 'Duphar' colloidal copper fungicide and BHC, lindane and 2,4,5-T acid were also displayed.

Protim Ltd. A film was being shown continuously on this stand on the subject of timber decay, its control and eradication. Among exhibits was the 'Protimeter', which instantaneously records the presence of moisture in timber, brick or plaster. The wood preservative, known as 'Protim', is both highly fungicidal and highly insecticidal and has been found effective in stopping dry rot, killing woodworm and termites, and preventing further attacks on treated timber. It contains dieldrin and chlorinated phenols; and successful tests have been carried out against many fungi, including *Polystictus sanguineus*, a common cause of white rot of hardwood in the tropics, and against termites at the Tropical Testing Establishment in Nigeria.

W. G. Pye & Co. Ltd. A selection of *p*H meters were exhibited, including the new 'Master', the 'Universal', and the 'Miniature'. Also shown were the Pye automatic titrator, demonstrating how routine titrations can be carried out without the use of skilled personnel; the conductivity meter 'W', for testing the purity of water; the 'Milcometer', an audio-frequency oscillator used in the observation of pests in the laboratory, when it is intended that they should remain in a particular position without any real restraint; and several other laboratory instruments.

Ratsouris Ltd. This exhibit displayed the RIS rodenticides based on warfarin and the RIS insecticides, for controlling the many insect pests of stored grain. The latter are based on lindane, dieldrin and malathion. Insecticidal dusts based on lindane suitable for admixture with grain or application to bagged grain were also shown.

Silver Creek Precision Corporation (*Microsol*) displayed the 'Microsol' mechanical fog generators which are used in all parts of the world for the prevention and control of pests and bacteria, largely in conjunction with pyrethrin - based insecticides and quaternary ammonium compounds. These machines are driven either by electricity or petrol engines and work reliably for long periods under most climatic conditions. The new model 304 is being used in malaria eradication programmes, in low-volume spraying work both inside buildings and outside in glasshouses, and in public health work to control flies and other disease-bearing insects by means of street fogging.



Photos: Protim Ltd.

Some common timber pests found in the British Isles, showing the damage they cause:
(1) *Furniture beetle*, Anobium punctatum.
(2) *Death watch beetle*, Xestobium rufovillosum.
(3) *House longhorn beetle*, Hylotrupes bajulus *L.*
(4) *Wood-boring weevil*, Pentathrum huttoni,

Solo Sprayers Ltd. exhibited hand sprayers, knapsack sprayers, suction and bucket pumps, limewashing pumps and lawn sprinklers.

The Standardised Disinfectants Co. Ltd. were exhibiting a representative selection from their wide range, amply demonstrating the world-wide scope of their products, which are, in fact, exported to 40 different countries. The products can be divided into six main groups as follows: (1) livestock dips and sprays based on arsenic, BHC, DDT, toxaphene, dieldrin and malathion, *e.g.* 'Zondagam' and 'Zondrin'; (2) timber insecticides and wood preservatives for preventing damage to timber by insect and fungus enemies at all stages of its production from felling in the forest to its final form as furniture or flooring, *e.g.* 'Lyxastan' and 'Protostan'; (3) insecticides for public health stored products and agricultural requirements throughout the world, *e.g.* 'Hexastan' and 'Lindastan'; (4) carbolic and pine disinfectants, *e.g.* 'Sizolin'; (5) a range of chemicals for use on rubber and other tropical plantations, *e.g.* 'Brunocide' and 'Brunostim'; (6) materials specially formulated for

spraying contractors using both ground and aerial application, *e.g.* ' Brunokop ', a copper fungicide, and 'Arsenicola', a potato haulm destroyer.

The Vigzol Oil Co. Ltd. Two models of the ' Blitzweed ' ground-crop spraying machine were displayed: the new model, which gives medium-volume application and will spray liquid up to 80 gal. to the acre, and the already well-known low-volume model. The low-volume model has a gear-type pump and the medium-volume model a vane-type rotary pump. The effective spraying width of the former is 19 ft. 6 in. and of the latter 22 ft. 6 in.

A full range of chemicals suitable for application by spraying was also shown. These included the growth regulators ' Blitzweed Super ' (MCPA), ' Blitzcleve ' (CMPP), ' Leykleen ' (MCPB), ' Turfspray ' (2,4-D) for weed control in all types of cereals and grassland; ' Banpest ' (DDT emulsion) for the control of many insect pests of farm crops; 'Blitspor' (copper oxychloride) for the control of potato blight etc.; ' Razetops ' for burning potato haulms before harvesting; and ' Naturfeed ', a foliar nutrient for use in adverse conditions.

WAECO Ltd. (' *Fumite* ' *Division*). The full range of ' Fumite ' insecticidal and fungicidal smoke pellets and generators were shown, including a smoke fungicide, ' Fumite TCNB ', which is unique in the world in containing tetrachloronitrobenzene (tecuazene). Treatment with this product begins 24 hours before planting in the greenhouse and affords protection to the young plants for the period before they are sufficiently strong to receive an external application. It is recommended for the treatment of botrytis and mildew on tomatoes, lettuces and chrysanthemums. All ' Fumite ' pesticides operate on the same principle: a chemical compound from which, by thermal means, a measured dose of active chemical is released in a clean particulate cloud.

' Brunolinum Plantarium ', a product of the Standardised Disinfectants Co. Ltd., being used in Ceylon for the prevention of fungus diseases of rubber-tapping panels

E. J. Woodman & Sons (Pinner) Ltd. Various horticultural products were displayed on this stand. One exhibit, the ' Horti-Ball ' universal joint, was described in a previous issue (WORLD CROPS, 1958, **10,** 190). The whalebone besom shown is an easy-to-handle alternative to the old-fashioned birch broom, which is often of inferior quality and difficult to obtain. Aids for easier gerdening included knee protectors, moulded rubber garden shoes and the ' Easi-Kneeler ' stool, which can be used also as a garden table. The ' Major ' and ' Minor ' greenhouse labels and park labels with a special stencil outfit for marking them were among the wide selection of labels shown.

The Exhibition catalogue constitutes a valuable guide to crop protection and pest control chemicals, materials and equipment. A few copies are still available and may be obtained, price 1*s.* 6*d.* (post free), from WORLD CROPS, Leonard Hill House, Eden Street, London, N.W.1.

Applying ' Fumite ' in a warehouse. The smoke diffuses everywhere within the space being treated, penetrating along the rafters and all round the sacks. The insects are forced out and destroyed in the open and a microscopic film of insecticide is left on all surfaces

The Provision of Water for Irrigation

DOUGLAS WOOD, A.R.S.M., F.G.S., A.M.INST.PET.

In this article the relative merits of irrigation by surface waters, brought from distant sources, and by subsurface waters, pumped to the surface on site, are considered.

The Barrage du Ghrib reservoir in Algeria

IN general, it is to the flat-bottomed valleys floored with recent alluvium and to the alluvial deposits fringing mountain chains undergoing erosion that we look when selecting land for irrigation-grown crops. Such valleys exhibit great variations in size – from the 300,000 square miles of the Ganges valley plain to narrow depressions or gorges with strips of alluvium only a few hundred yards wide. But whatever may be the geological and topographical characters of the terrain selected, they must all possess the one essential – the existence and persistence of adequate quantities of suitable water within reasonable distance or at a reasonable depth. If water is available from either source, an assessment can be made of the relative merits of distant reservoir or other source, plus canal irrigation systems, or, alternatively, irrigation by sub-surface waters pumped to the surface, on site.

Where there is access to rivers, to lakes or to reservoirs, either natural or artificial, it is apparent that operating costs for irrigating land can be inconsiderable: gravity may be the only power necessary to bring water to the land. But the capital costs for providing barrages to impound the water and canals to conduct it to the irrigable land may, even where pumping plant is not required, prove very high and will, under almost all circumstances, demand a considerable expenditure of time. When in operation, such systems are relatively cheap, but to provide them takes a lot of money and time.

Surface irrigation

Even if circumstances are such that money is readily available for these projects and the lapse of several years before they are in commission is of no importance, there are still certain inherent disadvantages which should be considered. Climatic, geological and topographical conditions in any chosen region will emphasise or modify these disadvantages.

In the reservoir itself – normally covering some portion of a river valley – or in a natural lake, *evaporation* is likely to be a cause of major losses of water: under extreme conditions it is said to amount to as much as three million tons of water per square mile per year. Unless the rate of recharge is of a comparable order, such losses can be formidable.

Losses of water from *soakage* into the ground from the reservoir can also be very considerable, particularly where the subsoil and country rock are permeable in character. In ranching country and other regions, where chains of small dams have been built in watercourses which are dry for most of the year, a study of the standing water level below ground shows a remarkable recovery: recharge must have come from soakage from the reservoirs, the water being thus preserved from evaporation or run-off to the sea. This heightening of the standing water level is a measure of the magnitude of losses from the reservoirs by soakage.

Geographically, the reservoir and headworks may be at a very considerable distance from the lands under irrigation. The Punjab is a case in point. Headworks in the foothills of the Himalayas provide water for irrigating land hundreds of miles distant in the hot plains to the south – land otherwise dependent for water on the monsoon, a single rainy season of limited duration and with a capricious degree of precipitation.

Trunk canals conducting water over such great distances are, like the reservoirs, also subject to evaporation losses. Unless they are lined with concrete or other suitable material – and for economical reasons this can rarely be practicable – they can also provide conditions for very considerable soakage losses: a figure of 30% is considered not uncommon for such wastage.

Through the trunk canal, the subsidiary canals and the distributary reticulation system, such water as has escaped evaporation and soakage will eventually reach the lands to be irrigated. Losses arising from these two causes of wastage may be very considerable, but they may be acceptable, as sufficient water may still be available for growing the required crops on the selected lands.

Less acceptable, however, is the fact that the water reaching these lands is by no means of the same quality as the water which entered the reservoir. Evaporation will have removed an appreciable – perhaps a very large – portion of the water itself, with the result that *the saline content of the water left in the canals will increase with distance and time from the reservoir*. Measurements made in the canals in the irrigated Gezira area of the Sudan show a marked increase in the *salinity* of the water as compared with that recorded at its source – the Sennar dam, on the Blue Nile far to the south.

In transit through unlined canals, water will also leach salts from the bottom and retaining walls of the canal, thus further intensifying the concentration of salts in solution.

From the above it can be seen that evaporation can, by concentrating salts, result in irrigation from surface waters eventually reducing the land to infertility. Soakage can and does have similar effects. Unlined canals conducting water through areas with highly permeable soils and subsoils can raise the standing water level in the vicinity of their courses to surface. In percolating through these porous deposits, the water leaches contained salts from the earth and, as evaporation takes place at surface in the waterlogged areas, these salts recrystallise and form a *salt crust* which will not support plant growth. In Western Pakistan, vast areas continue to be lost to agriculture in this way.

Apart from these various disadvantages, the importance of which is a matter of degree and will vary with circumstances, it may be thought that, once the initial heavy capital expenditure has been met, such systems of irrigation must be unquestionably preferable, since their operating costs should be small. This may be very far from the case. The *silting up* of the main reservoir by the loads of detritus deposited from the water of entering streams may be rapid, as in South Africa. There appears to be no remedy and eventually the reservoirs will cease to exist as such and dependent irrigation projects will come to an end. Silting of canals can also be a serious problem.

More troublesome still, and often resulting in unremitting labour and considerable annual expenditure, is the choking of the canal system by the

An irrigation canal in Algeria. This trunk canal is lined with concrete to prevent soakage losses. The water is carried great distances and evaporation losses are bound to be considerable

growth of weeds. This is particularly marked in systems where water use is intermittent and the periods of stagnation favour sub-aqueous growth of plant life. The Gezira canal system is an example of operating costs being greatly increased by such circumstances. Labour, supplemented by ingenious mechanical devices, removes the weeds, but the cure is only temporary.

Sub-surface irrigation

It is now easier to consider the relative merits of irrigation by the method just considered and by the alternative use of sub-surface water mechanically brought to ground level.

Before specifying the advantages resulting from the source of water being geographically on the lands to be irrigated – or, more accurately, vertically below them – it must be faced that this is not always possible, practicable or beneficial. There may be too little sub-surface water; the rate of recharge of the aquifers may be too low; the aquifers may be at depths too great, and the cost of drilling too high for irrigation by such means to be an economical proposition; the pumping levels may be deep and necessitate costly pumps and heavy power consumption; the sub-surface water may be unduly saline and harmful to plant growth, or likely to render the soil infertile over a period of time; or there may be no water at all.

These are matters which can only be determined by the geologist, the drill and the chemist. In a new and undrilled area the geologist can only say that conditions are or are not favourable for the accumulation, artificial withdrawal and natural replacement of large volumes of water. His opinion is still only an opinion; he cannot see below the ground and it is only the drill which can confirm or contradict the deductions he has made. The drill, penetrating perhaps hundreds of feet below surface, will determine if water-bearing formations do, in fact, underlie the chosen site; the drill will ascertain their depth and thickness, and something of their lithological character. Pumping tests will then measure rates at which water can be produced, and the pumping levels. The chemist can analyse the water and, with the agriculturist, decide if it can be used for irrigating crops and for what particular crops it is most suited.

Tube wells

Some knowledge of what sub-surface irrigation involves is required before an opinion on its merits can be formed. The modern method is to drill mechanically a borehole of large diameter (30 in. is often selected) to the underground aquifer, which may lie several hundred feet below the surface. The borehole is then lined with tubing, perforated or slotted, against the aquifer and the water is brought to the surface by a pump operated by some convenient source of power. Nowadays such a borehole is commonly known as a ' tube well '.

These tube wells are spaced over the area to be irrigated in such a way that the water which they produce is capable of reaching any part of the area which requires to be irrigated. Normally the water, having been pumped to the surface, is then led through pipes or small open channels

A subsidiary canal in a sugar plantation

Photo : Caterpillar Tractor Co.

to the irrigable lands. As these are immediately around the tube well, such channels are of no great length and the labour required to construct them over an area of, say, one square mile is not a serious consideration either in time or money. If there is an electricity supply available, the tube well pumps can be conveniently powered in this way; or a central diesel-electric power station or stations can be installed and electric current transmitted over the short distances to the surrounding well installations. Alternatively, each pumping unit can be operated individually by a diesel engine.

Power requirements

In comparing the two major systems of irrigation, this question of power can conveniently be considered first. Obviously the reservoir-canal system has the advantage that power is rarely required, as the water usually flows by gravity to the area to be irrigated. But there are also unfavourable circumstances: without power, only areas topographically attainable by gravity from the reservoir can be irrigated; the cost of many miles of trunk and subsidiary canals to bring the water to the lands involves heavy capital cost and much time for their construction; keeping these channels free of silt and weeds and maintaining their banks is a constant, and sometimes heavy, continuing charge.

A comparison of the water losses arising from evaporation and soakage favours the tube well. Water is pumped by the tube wells from underground aquifers, not themselves subject to evaporation; it goes straight on to the land to be irrigated and thus soakage is not waste. The internal reticulation systems conducting the water over the irrigable lands are common to both methods, as are the evaporation losses in these irrigation ditches on the cultivable lands. At all times a reservoir and its trunk and subsidiary canals are subject to evaporation and soakage losses; these losses go on just the same even when water is not being admitted to the irrigation ditches. But with the tube well system, the moment the land has received the required watering, the tube well pumps are stopped and the water for the next watering remains in the tube well and aquifer without any of the wastage involved in surface water storage.

It may be objected that these evaporation and soakage losses are not really so important, as adequate water for irrigation will still reach the land, but there is another aspect to be considered. Sites for reservoirs are selected and a dam is built to such a height as to provide sufficient water for the purpose in view. Similarly, the canals have to be large enough to carry adequate volumes of water. To allow for evaporation and soakage losses and still provide adequate water at the consumer's end of the line the dam wall has to be built higher than would otherwise be necessary – perhaps twice as high; the canals have to be larger – perhaps twice as deep. All this represents a heavy burden in capital cost and time, provides no additional water, and only gives the negative result of anticipating inevitable losses.

The time factor

The time element is an important consideration. If in some arid country the government is ready and eager to take action and has under consideration even one irrigation scheme to grow more food, what can be done to reduce the time element for its accomplishment? This may run into years – three, five, ten even, according to the size of the scheme and ease of access. During the years required for the construction of a surface scheme, not one grain of wheat or blade of grass can be grown by irrigation. Only when the dam is completed and retaining water, and the canals have been dug will any water reach the site.

Even where catchment areas are favourable and impounding water in a reservoir a matter of no great difficulty it is all too rarely that the agricultural lands to be developed are close at hand; canal construction over considerable distances has to be undertaken. These works take time and are liable to be exposed to danger from exceptional floods and other catastrophes.

If there is no alternative, then the reservoir and canal systems must be constructed and the long period of waiting must be faced, but it is well worth investigating an alternative before coming to a decision.

Where it is possible to obtain adequate and suitable water from below the ground and in the actual area which it is intended to irrigate, the prospects are very different. How long does it take to construct a tube well? Obviously this must depend on a number of factors, such as depth, nature of strata, type of drill etc. Under favourable circumstances one type of drill has completed half a dozen tube wells of an average depth of 350 ft. in one week; in such an area it would be possible to complete in a short time a very extensive tube well scheme, if several drilling rigs are in operation. Elsewhere conditions may be such that the time taken to complete a well is longer, particularly if modern machinery is not available. Even then

it is not unreasonable to suppose that tube wells of economic depths for irrigation should not, under less favourable conditions, require more than three weeks for their construction. Somewhere between the two figures is a reasonable estimate and so two tube wells per drilling rig per month would appear to be a generous time allowance.

If a tube well irrigation project is possible and each tube well is capable of irrigating 1 sq. km., an area of 100 sq. km. could be drilled by two drilling rigs and put under irrigation in a year. More attractive still – and this is the feature not always appreciated, but which should be emphasised – as each tube well is completed and energised a sq. km. of land can be brought under irrigation. Thus, in our hypothetical illustration, in three months 25 sq. km. are progressively under the command of a supply of water and, at the end of six months, half of the proposed 100 sq. km. is capable of yielding irrigated crops.

From the economic point of view, the tube well scheme is producing revenue long before it is completed. A good example is to be found in the Ganges valley, where very extensive tube well projects have been undertaken, and it is claimed that the capital cost will be offset in less than two years by the value of crops produced.

Need for advice

Tube well projects should not be undertaken without advice: geology, hydrology, agronomy and economics have all to be considered. It is all very well to instance the Ganges valley, where increasingly large areas are being brought under cultivation by these means as and when finance is available. There the above-mentioned considerations are well understood and have been confirmed by the construction of thousands of tube wells over the last 20 years or so. In territories new to such developments some care must be exercised and if no knowledge of subsurface hydrology is available test borings should be made. If the results of these are favourable, a tube well irrigation project can be planned. All details of the project must be carefully studied and proper advice sought even on such matters as the design of the tube wells, as badly designed and inefficient tube wells have in some countries produced disappointing quantities of water and have brought a measure of discredit to sub-surface irrigation.

In certain territories there may already be some information which will enable the geologist to recommend a modified scheme of a dozen or so tube wells, but there can never be anything wrong, if time is available, in seeking confirmation by suitable drilling tests, which will assist in the selection of pumps and power. If after such test, orders for pumps and power can be placed before the drilling of the main scheme starts, much time will have been gained.

Power supply

The method of powering of the tube wells is a problem which requires study. Very rarely will conditions be encountered where artesian flow eliminates power requirements. As irrigation is frequently undertaken in areas remote from any established supply of electrical power, special arrangements to energise the wells have often to be made. Briefly, these can be (*a*) the installation of diesel-electric generating stations on the land to power the tube wells (or groups of tube wells), each fitted with an electrically-driven pump; (*b*) the provision of individual diesel engine installations at each tube well to drive the pumps through gear or pulley and belt transmissions; or (*c*), where the pumps can be driven by detachable hydraulic motors fitted to their shafts, the provision of portable or interchangeable prime movers, such as agricultural tractors, powering a hydraulic pump; with this last system it may be possible to energise wells in rotation with less than one tractor per well.

Of the above systems of powering, the most costly in capital outlay is the diesel-electric power station with its ancillary transmission lines. But, so far as operating costs and maintenance are concerned, it may prove the cheapest. All the skilled labour required is that necessary to operate this one small generating station. The wells themselves are controlled by switches; measurement of water, if there is to be any complication of proportional payments for water used by individual farmer-consumers, is quite simply made by one unskilled attendant at the pump installation.

In countries where skilled or semi-skilled mechanical labour is scarce and in areas remote from mechanical assistance, individual diesel engines for powering tube wells, although a simple and obvious choice, are for reasons of operation and maintenance likely to prove troublesome. So, where this method of powering is selected, special attention should be paid to sturdiness, ease and simplicity of operation and maintenance of the engine chosen. These factors are far more important than initial cost.

The third system, that of a hydraulically-driven motor installed on the pump shaft and connected through high-pressure flexible hose to a hydraulic pump mounted on and powered by a tractor or any other readily transportable prime mover, has so far not been the subject of much practical experiment. With the introduction of hydraulic drive to tube well drilling rigs and test pumps, the method will become more familiar and may readily find a wide market, particularly for purely agricultural projects. When the land is not being irrigated and the tractor's power is not required to energise the pumps, it will be free for other work.

Before leaving this phase of the powering of tube well projects it can be remarked that any or all of the *ad hoc* arrangements for such powering can be discontinued if and when a major grid system of electrical power distribution comes within reasonable transmission distance of the tube well area. Discarding the temporary powering arrangements need not result in loss, for they can be – and often are – moved to and installed in some other area remote from grid electrical supplies where tube well projects or industrial developments are about to be undertaken or are already creating a need for power.

Operating costs

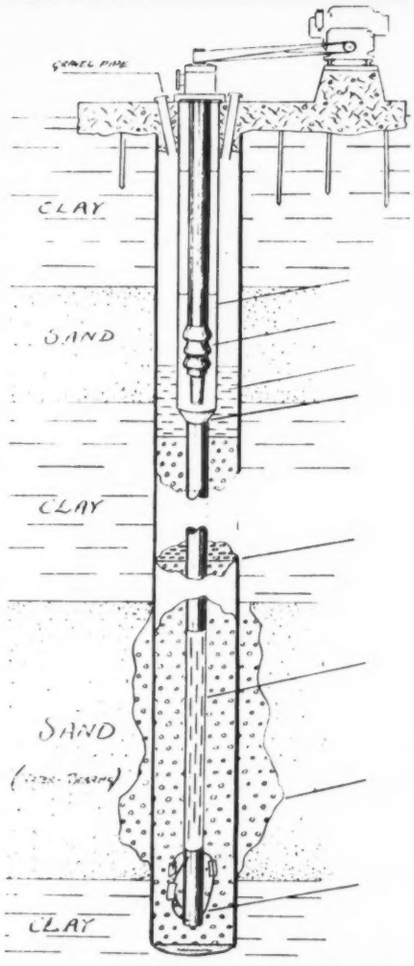
Observations on the operating and maintenance costs of tube well projects are appropriate and some figures from India are available. There, operation costs for tube wells, pumping at the rate of 3,400 Imperial gallons per hour for 3,500 hours per year, were about £800 per annum. These costs were made up of over £200 interest and depreciation charges on capital investment, and just over £100 for labour, maintenance and repairs; the largest item – £500 per annum – was for electrical energy to power the wells.

Photo : India House, London

A rotary rig at work sinking a tube well in a village in the Punjab. India today has the largest programme of tube well construction in the world

The cost of this electrical energy is directly related to the horse-power required by the tube well pump; this horse-power is, in turn, a function of the pumping head. The pumping head is directly related to the draw-down consequent on the rate of discharge. So, keeping the discharge constant, any reduction in the draw-down will have a direct effect on the electricity bill for the well. Improved well design can have striking effects on draw-down and reduce pumping heads by 75% or more. Thus, by correct well design, the major operational charge can be considerably reduced and the overall operational and maintenance charges can possibly be halved.

It is to considerations such as the above that attention should be directed in designing tube wells and in choosing machinery capable of drilling them to the selected design. Tube wells of 6, 8, 10 or 12 in. diameter are inadequate and should not be used in large irrigation projects. Modern design and experience will favour wells of the order of 30 in. or more in diameter, with a liner of adequate size surrounded by an annulus of gravel.



Reinforced concrete at well head
Piles for soft ground
Housing pipe to contain pump
Shaft-driven turbine pump
Clay seal on top of gravel pack
Reducing socket
30-in. borehole
Slotted pipe set in gravel pack
Enlargement of hole due to initial pumping filled with gravel by gravity
Bail plug for centring guides

Diagram of a tube well, with casing and pump installed

Water surveys

During the last few years in India, Pakistan, Iraq, Saudi Arabia and Iran, intensive surveys have been, or are being, undertaken to evaluate sub-surface water resources. Test-drilling programmes are in operation or projected and, resulting from these, is envisaged the construction of many thousands of tube wells for crop irrigation.

India and Pakistan have the greatest experience in tube well construction; it is significant of the success of their already completed projects that they have plans for the construction of at least 20,000 more tube wells and that some of these plans are far advanced. If to this total is added the numbers of wells which have been proposed by a dozen or more other countries in the eastern hemisphere alone, the potential volume of this form of water development can be seen to be of impressive dimensions.

Many projects, unfortunately, have not even reached the stage of a trial boring, because the government concerned has been overwhelmed and bewildered by a plethora of advice, both from international organisations and from consultants and operators in this particular field. Perhaps more helpful and time- and money-saving than many of the surveys which are being proposed and undertaken would be the immediate drilling of one properly designed test hole to ascertain the presence, volume and quality of water in any area to be studied. Sooner or later in any new area this test must be made, because the drill is the inevitable and decisive factor for all irrigation schemes drawing water from underground sources.

Recent Advances in the Irrigation of Pastures in New Zealand

BESSEL D. VAN'T WOUDT, PH.D.
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Maintaining pasture production during the dry summer months by irrigation raises problems which are not encountered when pastures are growing under conditions of adequate rainfall and lower temperatures at other times of the year. This summary of the results of experimental work on pasture irrigation in New Zealand draws attention to some new aspects of pasture maintenance.

RECURRENT summer droughts in New Zealand, with consequent slumps in pasture production, bring about a close correlation between the output of dairy products and rainfall. Feeding the cattle with stored hay and silage, made from excess spring pasture, and with summer crops of turnips and millet, grown in spring and early summer, has done little to change this relationship.

The possibility of maintaining dairy production during the summer months at a uniform level by the supplementary irrigation of a standard perennial ryegrass/white clover pasture has been studied since 1946. During the first five years, annual pasture production was increased through irrigation by just over 25% (Table 1), even though at that time the exact water requirements and the correct management of the pastures were not fully understood.

It has become apparent that, in order to obtain the maximum benefit from irrigation, several conditions need to be satisfied with respect to watering efficiency and the management and choice of pastures. These essential conditions are considered below under five headings. Their application has resulted in a substantial increase in pasture production during the years 1953–54 and 1954–55 (Table 1). Annual pasture production was nearly doubled during these periods because of the realisation of the summer potential for growth, although the benefit from irrigation was accentuated by rather dry spells, as is shown up by the yield from non-irrigated pastures (Table 1).

Irrigation of top soil

As a consequence of the annual top-dressing programme in which 2 or 3 cwt. of superphosphate are applied per acre, and the lack of penetration of the applied phosphorus beyond a few inches under the surface, the top few inches of soil under improved pastures in New Zealand retain most of the fertility. Root concentration is therefore heavy and micro-biological activity is high but just below the surface. Because of this, the top few inches need to be kept moist all the time, which means light waterings applied frequently. If the moisture content in these top few inches falls to near wilting point, pasture growth is virtually at a standstill, even though there may be ample soil moisture immediately below.

As a result of evapo-transpiration experiments designed to give a first approximation of the water requirements of pastures, subsequent calculations were based on 90% of open-water surface evaporation. This was measured from a concrete tank, 3 ft. in diameter and 3 ft. deep (standard

Photo shows dairy cattle on an overgrazed winter pasture in New Zealand

Table 1
Dry matter production in lb. per acre from irrigated and non-irrigated perennial ryegrass-white clover pastures at Rukuhia

Year: 1 *July–30 June*	*Irrigated*	*Non-irrigated*	*Increase from irrigation,* %
	in 1,000 *lb.*	*in* 1,000 *lb.*	
1948–49	15.5	12.0	29
1949–50	13.5	10.7	26
1950–51	10.5	8.1	30
1951–52	11.6	9.2	26
1952–53	13.6	10.9	25
1953–54	15.3	8.1	89
1954–55	15.3	8.0	91

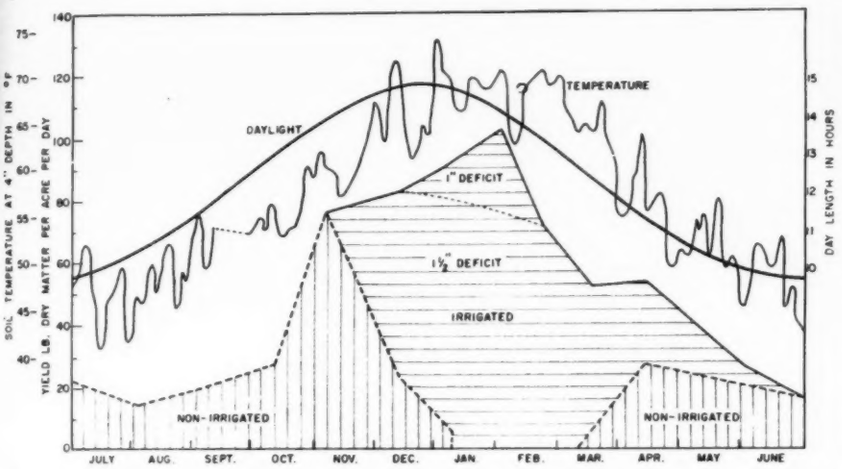


Fig. 1. Diagram showing the production of perennial ryegrass/white clover pastures with and without irrigation

N.Z. Meteorological Service equipment). Evaporation from this type of tank was estimated to exceed normal lake evaporation by about 15%. The figure of 90% takes into account an approximate 70% efficiency of the sprinkler irrigation system which was used. On this basis, irrigations were applied whenever the moisture deficit in the soil reached a certain value, the deficit being computed by a book-keeping system, adding daily evaporation and deducting rainfall and irrigation. Rainfall in excess of the deficit was disregarded as being of no use.

The conclusions reached were as follows:

Where measured on a clay loam, irrigation should be applied when the deficit rises to 1½ in. but some increase can probably be obtained by irrigation at 1 in. deficit during the peak of the summer, as shown in Fig. 1.*

A depression in yield occurred whenever the deficit was allowed to rise to 2 in. In the absence of rain and on the basis of 1½ in. deficit, the required intervals between irrigation, depending on the time of the year, are as shown in Table 2.

Attention to the evaporation records throughout New Zealand shows that the annual deviation from average does not generally exceed 10%. Over weekly periods the variation may be substantially greater, but on a monthly basis the differences tend to cancel out. Major variations in evaporation from area to area are caused by local topography. This has been roughly accounted for in the above computation. The figures given in Table 2 are thus a first approximation of the moisture needs of pastures on heavy soils throughout New Zealand.

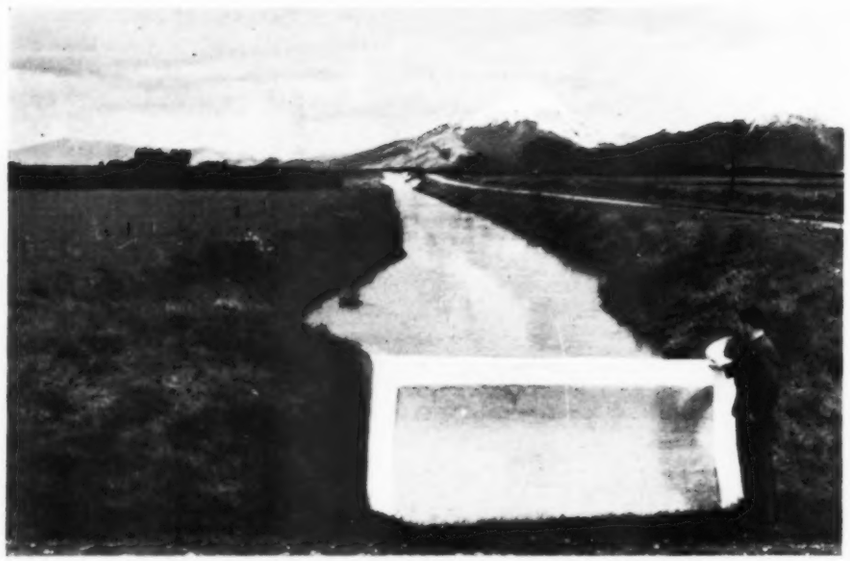
Sandy soils do not require more water but, ideally, smaller quantities of water need to be applied more frequently, which makes the problem an economic one, in which the labour, water and equipment cost of irrigating has to be weighed against the benefits to be derived from frequent irrigation. Some infestation by 'rust' occurred on these frequently irrigated pastures during the warmest weeks of the year, particularly on newly-established pastures, but there was no impact on yield or on animal health.

Regular water applications

Where intervals between irrigations are longer than those recommended, there is a loss of yield, not only because of moisture stress in the surface soil, but also because root growth is impaired during any period of summer drought exceeding two or three weeks. In that event re-growth of the root system does not keep pace with the dying rootlets, so that ultimately a skeletal root system is left. Re-growth of pastures which have not

A Maori cattle farm near Auckland, North Island

* The seasons are reversed in the southern hemisphere.



An irrigation ditch through pastureland in Central Otago, South Island

been watered for two or three weeks in the summer months is therefore retarded until the root system has recovered. This may take several weeks from the time that water is applied, following a period of drought. Regular water applications are therefore essential to keep the root system in a healthy condition.

It is also true, however, that once growth does start on such pastures, the initial yield tends to exceed that from pastures which have been well irrigated throughout. An analysis of the herbage at that time showed that the nitrogen content was substantially higher in the pasture subjected to drought. There is thus a suggestion that nitrogen has accumulated in the soil during the period of drought and this has boosted pasture production when there was no longer any growth limitation due to moisture deficiency.

Controlled grazing

The micro-climate near the ground must be controlled so that the crowns of the plants and the tillers are exposed to extremes neither of heat nor of cold. To achieve this, pastures should not be grazed lower than about 2 in. during the summer and winter. This can be effected by controlled grazing – by the subdivision of the pastures and the use of electric fences. By such means, an adequate protective cover of sward can be left and, in consequence, extremes of temperature near the ground surface are avoided.

Where the surface is not so protected, surface temperatures may exceed that of the air by as much as 30° to 40° F., whereas the temperature of the soil, immediately below a 2-in. protecting sward, tends to be slightly lower than that of the air. Thus the presence or absence of an adequate protective cover can make all the difference in permitting the growth of pasture on hot days.

Controlled flowering

A considerable decline in production occurs in late spring and early summer when the pastures flower. Vegetative growth must be maintained if there is to be maximum production. Successful attempts have been made to prevent flowering by hard grazing at the critical time of the year – usually the cooler spring period – when micro-climatic effects near the ground surface are not so significant. However, it seems that this method is only successful under certain climatic conditions. A warm dry spring, even with irrigation, induces flowering in spite of hard grazing and then two months or more may elapse before renewed, vigorous vegetative growth is again resumed.

With annual and semi-perennial grasses, such as Italian and short-rotation ryegrass, flowering cannot be controlled by hard grazing. The grasses flower anyway and in consequence production does not improve until towards the autumn. The indications are that the stronger the perennial nature of the grass, the better are the chances that vegetative growth can be maintained by grazing management. It is, however, likely that strains of grasses can be selected or developed which are particularly suited for irrigation during the summer months because of their sustained vegetative growth. Kikuyu, *Pennisetum clandestinum*, is an example; it rarely flowers under New Zealand and Australian conditions. With irrigation, production from this grass can be maintained at a continuously high level throughout the spring and summer.

Grass selection

Mitchell[1] has established that once a certain critical temperature is exceeded, the growth of perennial ryegrass and of other grasses declines. Dallis grass, *Paspalum dilatatum*, was

Table 2
Approximate intervals (in days) between irrigations of 1½ in. in the absence of rain

	Oct.	*Nov.*	*Dec.*	*Jan.*	*Feb.*	*March*	*April*
Flat, reasonably sheltered sites ..	19	14	12	7	13	15	24
Elevated, exposed sites	17	12	10	7*	11	13	22

* A desirable reduction to five days is rarely practicable under ordinary farming conditions.

Table 3
Excess of rainfall over open water surface evaporation at Rukuhia, in inches

1953					
July	*August*	*September*	*October*	*November*	*December*
7.01	2.63	−0.64	.80	−0.92	−1.90
1954					
January	*February*	*March*	*April*	*May*	*June*
−5.47	−3.53	3.91	2.27	3.67	3.36

shown to have a high temperature ceiling and, under most field conditions in New Zealand and Australia, it is known that this grass grows faster the higher the temperature.

The temperature ceiling for perennial ryegrass, however, is at a critical level in New Zealand summer conditions, where temperatures of 70 to 75° F. prevail, and in some summers, growth is depressed because of higher temperatures. For this reason, perennial ryegrass has been found unsuitable for irrigated summer-producing pastures in Australia because of the generally higher temperatures.

In order to obtain high production during the time of year when temperatures and hours of daylight are most conducive to high yields, a careful selection needs to be made of the sward components which react favourably to the prevailing temperature conditions.

Results of experiments

Provided that the temperature ceiling of the sward components is not exceeded, that the micro-climate at the soil surface is controlled by pasture management and that vegetative growth is maintained, a close correlation between pasture production, temperature and day length was obtained (Fig. 1).

Rainfall and evaporation data are summarised in Table 3. The pasture studied was top-dressed with superphosphate only; the potash supply was naturally high, while the nitrogen supply was solely dependent on the activity of the clover component. Nitrogen leached by rainfall during the winter limits growth in early spring. Consequently a nitrogen topdressing at this time of the year would bring the three curves of Fig. 1 closer together, as has been demonstrated in separate experiments.

During the spring, summer and early autumn, the experimental pastures were grazed and the production measured at three to four week intervals. At other times the sward was grazed when it reached a height of 6–8 in. In all cases grazing and measurement for production took place simultaneously. All measurements were in eight-fold on pasture plots totalling about two acres, with the exception of the results from irrigating at 1-in. deficit in January and February, as shown in Fig. 1; these were measured in duplicate only.

Summary

1. The need for keeping moist the top few inches of soil under improved New Zealand pastures by frequent and light irrigations is discussed.

2. A protective cover on the soil surface is needed to prevent extremes in micro-climate near ground level. This means grazing must be controlled.

3. Continuous vegetative growth in the sward is required to ensure high production in summer.

4. Sward components need to be selected whose temperature ceiling is not exceeded under summer conditions, otherwise a depression in yield will occur when temperatures are high.

5. If these conditions are satisfied, and soil fertility and the availability of water are not limiting factors, it should be possible to use the full productive potential of the summer months.

REFERENCE

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Photos: New Zealand Government Publicity Studios

The author is now with the Agricultural Experimental Station, University of Hawaii, Honolulu.

Better Water Management

Water is an essential plant nutrient. Higher yields of agricultural and horticultural crops can generally be obtained if water is applied at the right time and in the required amount. Too much water can be as harmful as too little. But in overcrowded Britain the demand for water for all purposes is constantly increasing and the need for economy in the use of irrigating water by correct application is becoming apparent.

The Agriculture Group of the Society of Chemical Industry recently arranged a ' Water Meeting ' to discuss the use of water in agriculture, under the chairmanship of Dr. G. W. Cooke of Rothamsted Experimental Station, and the following is a brief abstract of some of the papers presented at this meeting.

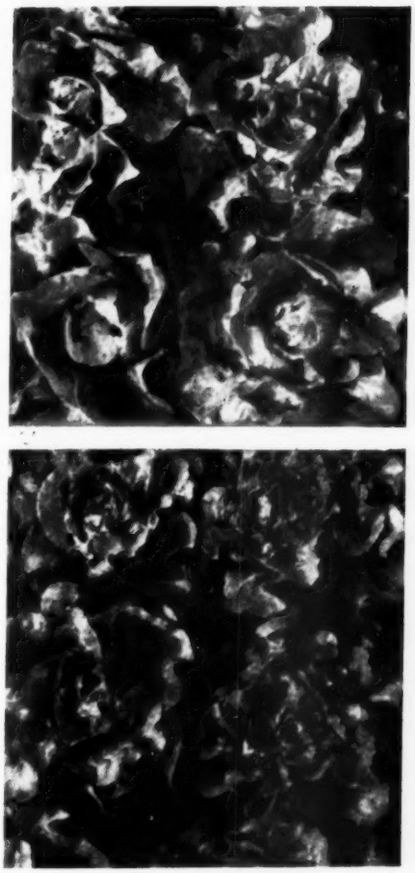


Photo: Miss J. Rubio, N.V.R.S.

The effect of watering on a horticultural crop. Lettuces of the same variety and of the same age grown under a wet (above) *and a dry regime* (below)

Some Aspects of the Irrigation of Vegetables, *by E. J. Winter, National Vegetable Research Station, Wellesbourne, U.K.*

The work of the N.V.R.S. is planned to have a practical bearing on the problems of vegetable growers and is not restricted to fundamental and theoretical considerations. The essential problems are when to water, and how much to apply; in the interests of economy it is desirable to apply the least possible amount of water which will give the required result.

Irrigation should be used only when the plants need water and not continuously; this would not only waste water, but would be impracticable throughout the summer owing to limitations of equipment, labour and water. Certain growth stages of plants are specially sensitive to drought or to wet conditions as assessed in terms of eventual yield. Irrigation procedure on a mixed holding must therefore be planned having regard to these sensitive stages.

(*continued on page* 220)

Farming Problems in Switzerland

IRENE DE MEURONS

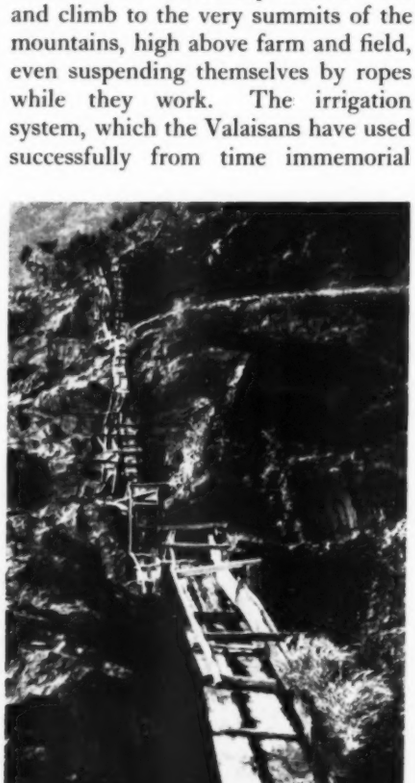
The Swiss farmer, owing to the very mountainous nature of his country and uncertainties of the weather, faces unusual difficulties. Agriculture in Switzerland is arduous and exacting.

The climate of Switzerland, though generally good, can often be disappointing to the farmer. This is particularly the case in the canton du Valais, which lies in the upper Rhone Valley, in southern Switzerland. The soil here is rocky and the summers are hot and dry, this part of Switzerland being famous for its lack of rainfall. For weeks on end, the sky remains cloudless, the sun shining down pitilessly day after day, scorching and drying up the vegetation.

Irrigation

The last vestiges of snow on the mountain tops melt and vanish and the streams become a mere trickle. If the rains do not come, the Swiss then turn to the sole remaining source of water. High up on the summits of the mountains, above the snow-line, are the glaciers – the ice-fields from which spring the life-giving streams.

To tap this precious source, the farmers must scale steep walls of rock and climb to the very summits of the mountains, high above farm and field, even suspending themselves by ropes while they work. The irrigation system, which the Valaisans have used successfully from time immemorial and which is called *bisse*, is indeed a marvel of human endeavour.



A bisse *bringing water from above the snow-line to the parched crops below. The small picture shows a close-up of the trough containing the water. At this point there is no need for a platform on which to walk, as there is a path alongside*

A narrow wooden gallery, several kilometres long, begins in the glacier and winds its way down the mountainside to the valley below. In some places, it passes under over-hanging crags; in others, it clings to steep walls of rock, or is suspended over ravines and precipices. A plain railing runs along its outer edge. Its floor is divided into two parts, one side being slightly raised to form a sort of pavement or side-walk, while the other provides a channel for the water.

A simple system of locks and gates serves to adjust the outflow, and the direction of flow can also be changed, so that the water can be made to pass first to one farmer's plot of land, and then to another's. The Valaisans walk up and down these galleries, directing and adjusting the outflow as required. During the dry, rainless season, the *bisse* is the only source of water, the one thing which stands between the farmer and ruin.

Fertilising

In the plains, or in river valleys such as the Emmental, the land has been worked for centuries, and so must be regularly fertilised if it is to continue to produce good crops. On these steep slopes fertilising requires ingenuity and considerable effort.

Liquid manure is extensively used, and for places, not accessible by cart,

These are photographs of the actual tillage operation described in the text. The cables connecting the pulley on the cart and the harrow can be seen. The photograph of the cart is, of course, taken from much closer range

a clever system of spraying has been devised. A pipeline, starting at the farm, runs up the mountainside to the fields above. It sometimes extends as much as 1,000 m., and is connected to a motor pump in the farmyard. The pipes, which are made up of sections, are laid where required and are taken up again and stored after use; where they cannot be transported by cart, they are carried by hand.

Cultivation

Tillage on the hillside is also a task calling for patience, skill and hard work. One day, I watched a father and his family working a field, on a steep hillside. Unable to use a tractor on such a steep terrain he had secured a cart on the hilltop to a fir-tree by an iron chain. A pulley had been fixed to the cart, and a similar pulley was attached to some poles on the other side of the field at the bottom of the slope. The pulleys were connected by steel cables to the harrow, and the whole was driven by a small motor, set up in the lane below. The father was in charge of the pulley on the hilltop, his wife operated the motor, while the son guided the harrow. The motor was started, the steel cable tautened and the harrow was pulled upwards, the young man walking behind and directing it. When the harrow reached the upper edge of the field, the old man gave a signal; the motor was stopped, the cables adjusted, and the harrow was turned around. Then the motor was re-started and the harrow moved quickly down the slope, the young man now running behind it. In this way, some 50 upward and downward trips were made and the hectare of land was harrowed.

Soil replacement

The vineyards between Villeneuve and Geneva are on slopes from which the soil is constantly being removed by the combined action of sun, wind and rain. Because of this, soil has to be replaced annually. As the terraces are inaccessible by cart, soil has to be transported in baskets, each containing 230 lb., and these heavy loads are carried up by men on their backs.

Agriculture in Switzerland is so arduous and exacting, and must so often be pursued under conditions where modern machinery and tranport cannot possibly be utilised, that human labour is still basic to production. So much is this the case that children at elementary and secondary schools, in rural districts, are given ten days' leave in June for the haymaking, after which they go back to school until the harvest. They are then given a further ten days to help their parents bring in the harvest. The longest holiday – the summer vacation – never exceeds four weeks. So the children learn that work comes before holidays.

Thus the Swiss farmer, by strenuous work and sustained effort, makes a vital contribution to his country's economy. The land cannot be made to produce sufficient to feed the Swiss for much more than a part of the year, but whatever it can be made to provide, the Swiss farmer compels it to yield, and often without modern machinery. Swiss farming, in short, is very much a matter of sweat and toil, ingenuity and wise planning.

Photos other than those illustrating tillage on the hillside, which were taken by the author, are reproduced by courtesy af the Swiss National Tourist Office, London

Bringing home the hay in the mountains

Holland is world-famous for its ancient windmills. The management of water through a system of canals, drains, ditches, watergates and spillways is highly organised in the Netherlands

A modern windmill. The correct application of water requires a knowledge of intricate soil–water relations, which is now an important subject of research in the Netherlands

Better Water Management

(*continued from page* 217)

In general, the wetter the growing conditions, the more foliage is produced; this is usually accompanied by a smaller increase in yield of marketable produce, such as cauliflower curds, carrots, radish, peas etc. There is a relationship between plant spacing, water supply and plant nutrient status.

An instrument for inferring the current soil moisture deficit under a given crop has been developed.

Water supplies are limited and growers are in competition with other consumers, including industry and domestic users. It is essential, therefore, to irrigate only when a definite increase in yield or quality can be expected.

Crop Growth and Availability of Water, *by Ir. W. C. Visser, Director, Soil and Water Research at Wageningen, the Netherlands.*

The supply of fertilisers in Holland is adequate and water has now become the limiting factor in agriculture. The major problem is therefore water management: *i.e.* (*a*) dealing with excess water and (*b*) making good deficiencies. It is estimated that 70% of the agricultural land needs to be drained; the remaining higher lands are glacial sands with low water retention.

Research on the subject of water-table management was started 50 years ago and the first step was to determine the relation between the ground water table and the water level in the ditches for different soil conditions. The second step was to study the soil moisture potential in the root zone – the problem of the capillary flow of soil moisture for different soils. The third step was to study the problem of moisture loss by evaporation from these soils and the movement of moisture away from the root zone.

There are 250 soil types in Holland and for each of these they have now worked out the optimum water table. If the water-holding capacity of the soil is high, a deeper water table is allowable; for average conditions, 70 cm. is the optimum depth of water table.

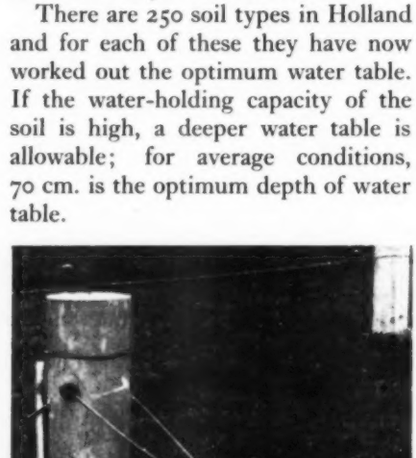


Photo : Miss J. Kullman, N.V.R.S.

Prototype of an instrument for inferring the current soil moisture deficit from a mechanical integration of rainfall and evaporation

Soil moisture tension is, however, considered to be the main factor. The plant fights a losing battle for moisture as the moisture tension increases. This has been shown by lysimeter trials with sand, clay and peat soils, with grass.

The Measurement of Solar Radiation and its Use in the Irrigation and Growth of Plants, *by E. R. Hoare, National Institute of Agricultural Engineering, Silsoe, U.K.*

The distribution of actinic energy in the solar spectrum shows considerable variation, the relative value between summer and winter being 10:1.

A number of instruments for determining solar energy were described: a black body instrument; a distillometer, in which the evaporation and condensation of carbon tetrachloride is used as a measure of the receipt of solar energy; an integrating solarimeter – a thermocouple with an amplifier; an artificial leaf evaporimeter, consisting essentially of a moistened strip of filter paper between two electrodes; and the photo-electric cell.

It has been found that there is a close relation between the rate of transpiration and the amount of solar energy, and by adding water and plant nutrients in proportion to the amount of solar energy being received extremely high yields have been obtained, *e.g.* for tomatoes under glass, between 80 and 90 tons per acre. As the NPK mixture used was an arbitrary one, there is room for further and more precise work, but the results already obtained are sufficiently striking.

Conserving Soil with Pastures

P. GUERIN

(Tasmanian Department of Agriculture)

The author discusses the part that pastures play in conserving soil in areas where water erosion is a problem.

WHEN raindrops beat down on a bare finely-worked soil they shatter the soil crumbs and produce a soupy mud, some of which settles out and blocks up the fine cracks and pores in the surface of the soil, so forming a thin layer of densely packed soil particles, a surface seal or ' crust '.

Water can pass through such a surface seal only very slowly. What cannot soak in must, of course, run off down the hillsides into the creeks and rivers, taking with it a lot of the stirred-up mud.

Types of erosion

The removal of precious top soil in this way is called *sheet erosion*. Although it is by far the most common form of erosion by water, it can easily remain virtually undetected.

Trickling down the hillside, this water, with its mud in suspension, follows small depressions, furrows and wheel tracks. Gradually the flow increases both in volume and in velocity until it forms streams. If its velocity is fast enough, the waterways or cultivation marks are scoured out, forming another type of erosion called *rill erosion*. The majority of rills are of cultivation depth.

When a lot of muddy water flows at even greater velocity, deep gullies or ravines may even be torn out and produce spectacular effects of *gully erosion*, although the major damage is actually done by sheet erosion.

In actual fact, water moving slowly over an extensive area can effect considerable soil removal. Water running at a velocity of less than one-fifth of a mile per hour is sufficient to move clay particles. Soil particles up to the size of coarse sand can be moved by water running at a velocity of approximately $\frac{1}{2}$ m.p.h., whilst a velocity of $1\frac{1}{2}$ m.p.h. can move stones an inch in diameter.

The silt deposits, mudbanks and deltas at the mouths of rivers are a grim reminder of the amount of soil carried down over the years.

The role of pastures

When rain falls on a dense pasture instead of on a bare cultivated soil, the leaves of the pasture plants absorb the force of the pounding raindrops.

After striking the leaves of the pasture plants, the raindrops trickle down the plant stems to the soil below. Consequently the raindrops do not pound the soil; a surface seal does not develop, and so the rain water soaks in more quickly. In addition, because there is no mud, the water which runs off, if any, is clear. Thus the first function of pastures in the conservation of soils is to protect the soil surface from the pounding rain.

Healthy pasture roots penetrate very thoroughly through the soil in which they grow. In doing so they break up and loosen the soil mass, particularly the top few inches. The soil beneath pasture becomes more crumbly and porous. This allows better infiltration of the rain into soils with consequently less run-off.

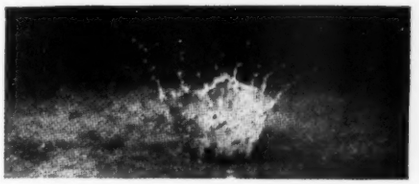
Pastures encourage worms in the soil and their burrowing habits open up the soil and so permit water to percolate through it more readily.

When pastures die and decay they form humus, which promotes good soil structure, so making the soil more absorptive; plant food is gradually released and its fertility is thus improved.

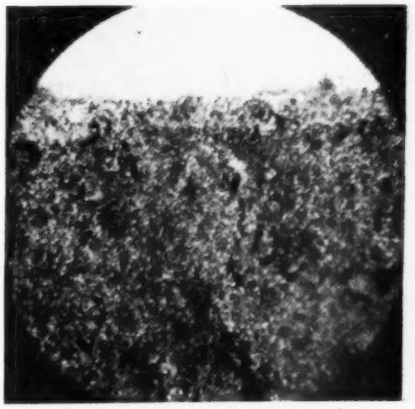
Thus a soil under pasture becomes more friable and easier to work, more absorptive and more fertile. However, such gains could easily be destroyed through excessive cultivation and cropping.

Cultivation effects

Excessive cultivation and cropping ruin a soil in four ways. Firstly, cultivation destroys the covering of pasture and exposes the soil. Then it smashes down the friable crumbs and, if overdone, reduces them to a powdery dust which readily turns into mud when it rains and yet sets hard when



A falling raindrop bombards the soil



The surface seal or 'crust'

Contour furrows. On hillsides furrows 6 in. wide, 6 in. deep and 6 ft. apart will hold up an extra ½ in. of rain. The distance apart of the furrows will depend on the slope

it dries. It is either too fine or too cloddy. Thirdly, cultivation encourages humus to decay, thus bringing about a deterioration in the soil structure. Finally, crops take from a soil substantial quantities of plant foods which are not returned to it. This reduction in soil fertility can be offset to a large extent by the use of fertilisers.

So pastures nourish and protect a soil, but cultivation wears it out. The question is how should the land be farmed for cropping?

Cropping soils

The best plan is to adopt a rotation whereby periods of cultivation alternate with periods of pasture. An overall set rotation cannot be laid down, as it will vary from area to area, and on some farms even from paddock to paddock. How to determine the balanced rotation depends on several factors, the most important being the type of soil and the farming methods practised.

(*a*) *Type of soil.* Some soils initially have a good open structure which does not break down quickly under cultivation. Other soils pulverise into dust after only a few cultivations. Some soils build up more quickly under pasture than others. It pays to err in having too long a period of pasture rather than not enough.

(*b*) *Farming methods.* The erosion risk is greatest on a finely-worked bare soil. Farming methods which make tillage less destructive help to protect the soil against water erosion. These include: (1) leaving the soil, when under fallow, rough with trash on the surface for as long as possible before breaking it down to a seed bed; (2) using the right tillage implement at safe speeds; (3) working the soil at the right water content – neither too wet (puddling) nor too dry (dust); (4) working across the slope on the contour, so that each tine mark will act as a miniature dam and hold up the water, so enabling the rain to be absorbed where it falls.

In choosing the rotation, the aim is to have a period of pasture under which the humus and crumby nature of the soil, destroyed through cultivation and cropping, is restored. A cultivation programme should be planned which gives the best crop with the least damage to the soil crumbs. Unless the correct balanced rotation of pasture and cropping is achieved, soils will erode and yields will gradually decline.

Hill country

The erosion risk becomes greater with increasing slope. As slopes become steeper, a stage is reached where, no matter what cultivation methods are used, soil erosion occurs if crops are grown. This upper limit for cultivation will depend mainly on the soil structure. Soils of excellent crumbiness can be cultivated to very steep slopes without undue erosion risk. However, on many farms in this area the excellent structure has been abused, causing sheet erosion and loss of valuable topsoil. Areas subject to heavy downpours of short duration have a greater erosion risk than areas where the same amount of rain is spread over longer periods.

Where soils are unsuitable for the cultivation of arable crops, the answer is permanent cover with pasture.

On the steeper parts of these permanent pasture areas rapid run-off can be checked by ploughing contour furrows.

These are single - furrow lines ploughed across the hill on the contour to hold up and absorb the run-off. The degree of slope which will determine the upper limit for furrowing will depend on the equipment available.

But what about the country on which it is too steep to run contour furrows? Unless, on this steep country, there is the equipment to establish and to maintain a dense permanent pasture, such as aerial topdressing and vermin control, the wisest land use is to leave these areas under trees. The trees may be the natural scrub or tree species of economic value can be introduced.

In any case, it is best to leave the development of these steeper areas until the pasture on the lower slopes is well established.

Pastures, whether temporary or permanent, are a vital link in the practice of conserving the soil.

Abstracted, with permission, from the *Tasmanian Journal of Agriculture*, August 1957.

Photos: South Australia Department of Agriculture.

Better Bananas

A series of new and better varieties of bananas, which are both more productive and more resistant to attack by plant diseases are likely to become available within the next few years from South America and the West Indies.

Research into the breeding of the new varieties, which has recently been intensified, is expected to lead also to considerable economies in the actual process of banana growing.

Thus smaller and more easily handled banana seed-pieces are being developed. Whereas at present new banana plants are started from pieces taken from an older plant, which often weigh several pounds and are about the size of a football, smaller pieces weighing perhaps only a few ounces should be useable in the future.

(Right) *Harvesting tea.* (Above) *Preparing white cabbages for the market – a field team at work on the 'Hsi Kuang' Agricultural Producers' Co-operative at Chengtu, Szechuan Province*

Agricultural Plans for China

HUA SHU*

This is a report from China on plans for greater agricultural production in the next five years and on achievements during the five years to 1957

IN China's Second Five-Year Plan (1958–62) the development of agriculture will parallel that of industry. This is possible because the First Five-Year Plan (1953–57) did more than lay a preliminary groundwork for industrialisation. It also shifted Chinese farming from an individual to a co-operative basis – and its targets for the main crops were fulfilled. Last year's national output of grain was 185 million tons; of cotton, 1.64 million tons. The preliminary plan for the next five years requires that by 1962 the grain crop should reach 240 million tons and the cotton crop 2.15 million tons.

Connection with industry

The greater attention to agriculture will in turn increase the speed of China's industrialisation, which centres on the growth of the capital goods sector. It will ensure faster improvement in the living standards of the people – particularly of the 500 million peasants. Local governments are mapping out ways to implement it in their areas. Members of farm co-operatives are discussing how to raise yields per acre.

The policy of parallel development flows from the interdependence of industry and agriculture in China's economy. The light industries, responsible (in value) for half the entire national industrial output, still obtain four-fifths of their raw materials from the farms. Agricultural products, raw or processed, make up four-fifths of the consumers' goods in China's home markets and comprise three-quarters of her exports.

Agriculture has a bearing not only on light, but also on heavy industry. The rural areas already use 50% of the nation's output of coal, 12% of its pig iron, 80% of its kerosene, 30% of its timber. Their needs for chemical fertilisers, insecticides and farm machinery are immense.

Farming, of course, carries the direct burden of feeding and clothing China's vast population. It is true that the population increase, which is 2% or some 13 millions a year, has been outpaced in recent years by the 4% average annual growth of grain output. But the living standards of the people, particularly the peasants, are still low. A higher rate of growth is needed to increase *per capita* consumption and income.

Chinese agriculture faces special problems. One is the small amount of cultivated land relative to the large number of people. This amounts to 280 million acres – only a ½ acre per head of the rural population. Yields per unit area are still low – some 1,250 lb. per acre for grain† and 250 lb. for cotton. In spite of the considerable water conservancy work done in the past years, natural calamities continue to be a formidable threat.

Increased production

There are two ways to meet these problems – reclamation of waste and virgin soil and the increase of yields in areas already being farmed. Though almost half of China's arable land is still untilled, to bring it under cultivation requires a degree of mechanisation, and of financial investment, beyond present resources. During the next 10 years only some 2 million acres will be reclaimed annually.

Maximum effort will be concentrated on the increase of yields per acre – for which China's manpower, climatic and other conditions are very favourable. The main direction for the development of Chinese agriculture is toward greater intensiveness, as in Japan or Western Germany. Extensive methods like those used in the Soviet Union or

* Associate Editor, China Agricultural Journal.

† Tuber crops (sweet potatoes, potatoes etc.) are included in the calculation, 4 lb. being reckoned as 1 lb. of grain.

the U.S.A. do not, in general, suit China.

With regard to increased yields per acre, the targets for the next 10 years have been set in the Revised Draft Programme for Agricultural Development for 1956–67:

Planned increase in grain yields
(in lb. per acre)

Region	1955	1967
North of the Yellow River	990	2,640
Central China ..	1,373	3,300
South China ..	2,640	5,280

In cotton, the nation-wide average should rise from 233 lb. per acre to 264, 396, 528 or 660 lb. per acre, depending on local conditions.

Are these targets feasible? By 1957, *i.e.* 10 years ahead of schedule, those for grain had already been reached in 65 of China's nearly 2,000 counties and municipalities; and in some, even surpassed. Averages in a number of counties south of the Yangtze have soared to 6,600 lb. per acre, and in one to 8,300 lb. Of cotton-producing counties, about an eighth have reached 264 lb. per acre – and five have topped 660 lb. The main factor in all these cases has been the more intensive cultivation made possible by co-operative labour.

The actual nation-wide steps being adopted to raise yields per acre fall into three main categories: water conservancy, increased use of fertiliser, and mechanisation.

Water conservation

Several big river-control projects built during recent years have helped to curb the flood danger and extend irrigation. The smaller local or farm-size works, however, have contributed most directly to higher yields. During the First Five-Year Plan China's irrigated farmland increased from 52 million acres in 1952 to 87 million acres in 1957. About half of the rise resulted from work done in the single winter of 1955–56, when village China passed over, *en masse*, to co-operation. This was the main reason why the nation's grain harvest in 1956 – a year of fairly widespread natural disasters – was better than in the good-weather bumper crop year 1955.

Most Chinese peasants today have heard of the 80-mile long Mang River in northern Honan province. Rising in the Loess highlands, it used to threaten 35,000 acres of farms with flood and carry vast amounts of good soil down to the Yellow River in the form of silt.

In the winter of 1955 the peasants all along its length, newly grouped into co-operatives, decided to tame it with ' 100 reservoirs, 1,000 wells and 10,000 ponds '. They also planted trees along its upper course and built two dams and a spillway. In the severe 1956 flood season, in consequence, only 5,000 acres were inundated, and in 1957 none at all. Because of improved irrigation one county on the lower Mang reached its 1967 yield-per-acre goal, 2,640 lb. of grain, 10 years ahead of schedule.

This example shows what can be done in all the two-thirds of China's cultivated land, which are still short of irrigation facilities.

Still another big job to be tackled is field drainage. In the five provinces of Hopei, Honan, Shantung, Anhwei and Kiangsu from eight to 16 million acres of land are subject to annual waterlogging from rains – with an avoidable grain loss of between five and 10 million tons.

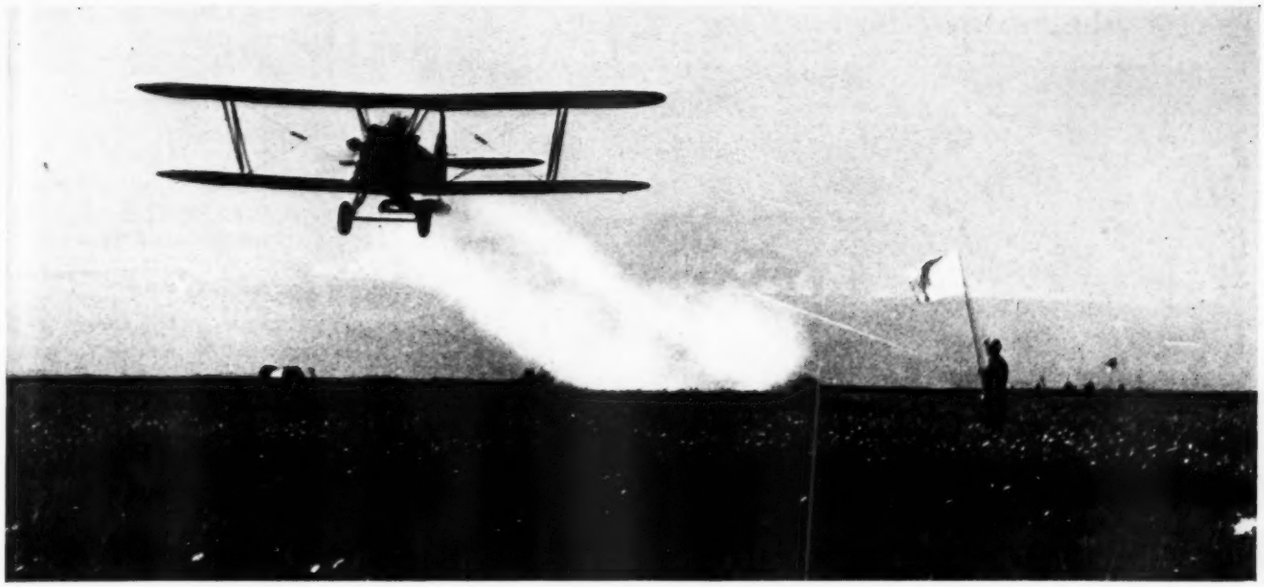
Fertilisers and manures

One pound of nitrogenous fertiliser added to the soil can give an extra yield of 3–5 lb. of rice, 2–3 lb. of wheat, or over 1 lb. of seed cotton. Phosphate fertilisers are about half as effective. In one section of the southern province of Kwangtung, near Swatow, the use of chemical fertilisers has raised the average rice yield to 6,600 lb. per acre. In Laiyang county in the northern province of Shantung it has led to a per-acre crop of 3,300 lb. of wheat. China today, however, is still short of chemical fertilisers, as domestic production amounts to only about 9 lb. per cultivated acre.

In 1957 the national production of chemical fertiliser was 755,000 tons. Though nearly three times more than in 1952, this was still very inadequate. Thirteen major plants, begun during the First Five-Year Plan, however, will have an annual capacity of two million tons when completed. The biggest, built with Russian aid in Kirin in the north-east, began operating last October. Its annual output of fertiliser can increase grain crops sufficiently to feed three million extra people a year. In the Second Five-Year Plan the Kirin works will be expanded to four or five times its present productive capacity. In addition to many small works, big producing units are being built at Lanchow in the north-west, Nanking on the Yangtze and Taiyuan in North China. The three works are planned for completion in 1958, 1959 and 1960 respectively. By 1962 China will be producing between five and seven million tons of chemical fertiliser; by 1967 about 15 million tons.

At present, however, most farms must rely mainly on natural manures – animal and human excreta, composts, pond silt, ashes, seaweed etc. Con-

Irrigation. Water buffalo turning a mill to raise water to the fields – this old method has now been replaced by electric pumps



Aerial spraying of a crop against pests

siderable amounts will be obtained through increased pig raising. The present cry in the countryside is 'Stalls for all cows, pens for all pigs, chicken houses for all poultry, latrines for all the people '.

Mechanisation and farm tools

Mechanised farming is China's goal, but it cannot be reached quickly. Not only is industry still too weak, but time is needed to design farm machines specially suited to the wet-rice fields and for operation on hillsides. During the First Five-Year Plan millions of improved steel ploughs and other animal-drawn tools were supplied to the peasants. In the Second and Third Five-Year Plans these will still be the main tools on the farms.

Labour shortage

With so much manpower, does China need to mechanise? Since they combined in co-operatives the peasants have found that they can do so many new things that there is a rural labour shortage, especially in the busy seasons and in areas where double or triple cropping is undertaken. The question for China is not whether to mechanise the farms, but how to do it, because of the great variety of terrain, soils, climate and farming techniques for different crops, of the present shortage of petrol and of the fact that the co-operatives do not have sufficient funds to purchase specialised machines for different jobs and demand multi-purpose ones.

This must be taken into consideration when designing farm machinery and tools. Tractors are already being manufactured at Tientsin and a new plant is ready to go into production at Loyang. Models will range from 6 h.p. to 100 h.p. Chinese engineers have succeeded in designing tractors that run on coal gas and converters to adapt diesel generators to this more plentiful fuel. Research is also being done on machinery powered by water and wind.

This year 38 newly designed mechanised implements are being manufactured experimentally. For the paddy fields of the south there are a rice-transplanting machine, a simplified rice harvester, a machine plough and a power-driven thresher. For the north-eastern wheat fields there are double-share ploughs, harrows and small-sized combine-harvesters. Also being made are cotton pickers and machines to harvest other industrial crops; and mowing, shearing and milking machines for the pasturelands.

Small lorries designed for rural areas, with a capacity of less than one ton, are now on the drawing board. Each will cost only as much as a cart and two mules. Pumps and other machinery for water conservancy and irrigation will be produced on a large scale.

It is clear why, in implementing the policy of parallel development of industry and agriculture, China's key principle of priority for heavy industry cannot, and will not, be forgotten. Were it to be ignored no part of her economy, including farming, could possibly be modernised.

Technical News

Articles in the June issue of some of the other journals in the Leonard Hill Technical Group include the following:

Automation Progress. – ' Electronic Controls at a Modern Sugar Plant ', ' The Instrumentation of Chemical Process Plant ', ' Electro-magnetic Brakes and Clutches in Recent Automatic Plant '.

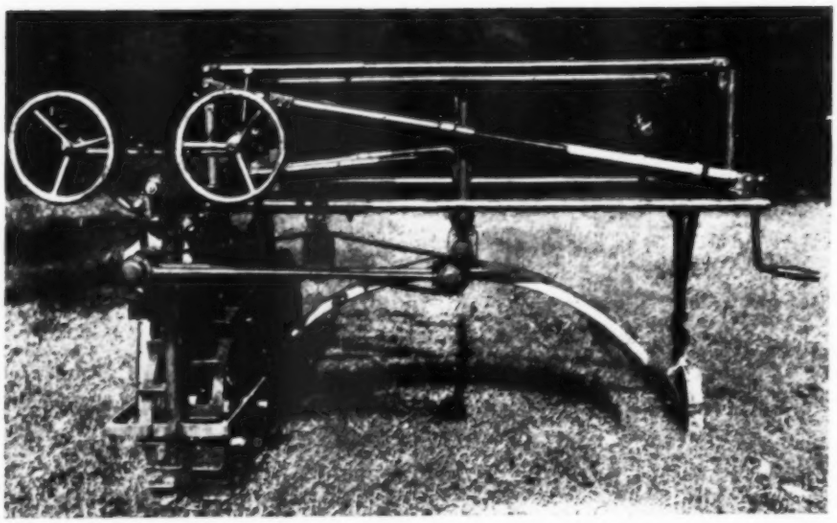
Manufacturing Chemist. – ' Preview of the Chemical and Petroleum Engineering Exhibition '.

Dairy Engineering. – ' Electrical Equipment for Dairies ' by K. H. Harding, ' Maintenance and Control of Refrigeration Plant ', by H. Burley, ' Survey of Refrigeration Plant ', ' Milk Publicity: A Comparison between British and American Methods ', ' Spring Meeting of the Society of Dairy Technology '.

Public Works and Muck Shifter. – ' Site Clearance ', by R. J. Salter.

Food Manufacture. – ' The Elimination of Pathogens from Frozen Whole Egg ', ' Science and Sugar Confectionery ', ' Review of Laboratory Furnishings and Equipment ', ' Fundamental Aspects of the Dehydration of Foodstuffs – 2', 'A New Type Dutch Sugar Filter '.

Mechanical Harvesting of Tea



Three-wheeled tractor with wheel-stabilising device for work across slopes. The arched cutter bar of the mounted tea harvester is visible, but fan, ducts and hopper have been removed

Tea has been grown in Georgia, one of the southernmost republics of the U.S.S.R., for 40 years and the importance of the crop has increased tremendously. In 1921 only 2,500 acres were grown; in 1957 this area had been raised to 160,000 acres. As a result of this phenomenal increase, there have been continued efforts at mechanisation, especially of harvesting, made chiefly by the State Agricultural Design Institute at Tiflis, the capital of Georgia.

The research workers in the Tiflis Institute have designed several portal-type tractors, which are unique in having a hydraulic stabilising device which keeps the wheels vertical all the time, even when the tractors are working across terraced and unterraced hillsides. In addition, work has been concentrated on developing a number of experimental tea harvesters which can be mounted on these tractors for work in the plantations. Some have been designed on similar lines to prototype mechanical pluckers tested in Assam, but a considerable amount of research has also been carried out on an experimental pneumatic harvester designed by Guliev and Chelidze.

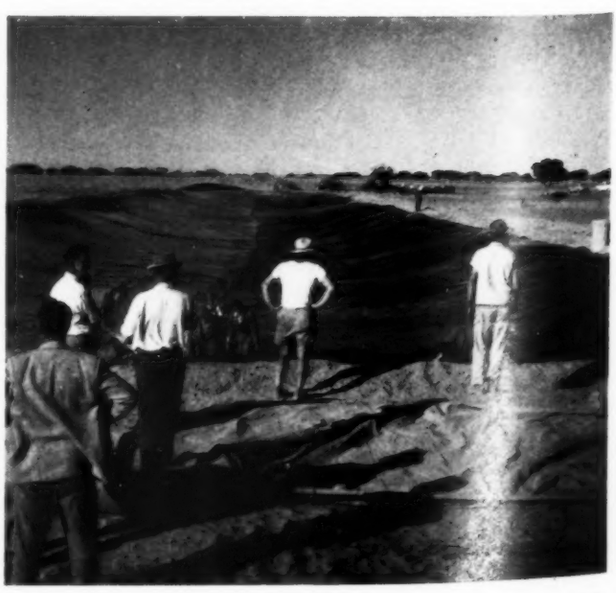
A powerful fan, with a capacity of 780 cu. yd. of air per min., was installed on a tractor, so that the inlet duct passed over the top of the tea bushes. The suction produced by the fan was sufficient to tear off tea tips and draw them along the duct to a hopper. Measurements were made of the air speeds needed to do this and of the proximity of the duct opening to the bushes necessary to allow the suction to tear off the tips. The theory of the method is sound, but results so far indicate that it is not possible to harvest tea in this way without causing considerable damage to the tender parts of the leaves.

The harvester which shows most promise is a mechanical one designed by Kopaliani, of the Tiflis Institute. In this machine fingers on an arched frame guide the tea tips to special three-stage reciprocating blades. The suction produced by a fan draws the severed tea tips along a pair of ducts, at the end of which they are deflected by a baffle board into a hopper. The quality of work of this machine is claimed to be very good and the yields from the tea plantations on the Kirov Sovkhoz have increased annually since the first few mechanical harvesters were introduced some five seasons ago. During this period improvements in design have been made and now only slight further modifications are necessary before full, large-scale production of the machines can be authorised.

Tests for Reducing Water Evaporation

Another stage in experiments carried out by the C.S.I.R.O. in Australia on a method of reducing water storage losses previously described in WORLD CROPS, 1957, **9**, 250. The construction of an experimental seep-proof dam was completed in November 1957. Two large sheets of polythene plastic were unrolled and spread over the bottom and sides of the dam; the two pieces were then heat-sealed to form one piece by a sealing process developed in Melbourne by Plastalon Pty. Ltd. The picture shows the first stages in laying the second half of the plastic sheet. The air bubbles were eliminated when the plastic covering was laid on the dam.

The dam has been filled with water and further tests will enable the C.S.I.R.O. to obtain complete information on the effects that temperature, sunlight, humidity and wind behaviour have on the efficiency of the cetyl alcohol process in reducing evaporation. These factors affect the rate at which the cetyl alcohol spreads and also the surface concentration of the chemical film necessary to reduce evaporation.



The use of plastic linings for reservoirs in New Zealand is discussed on page 198.

New Publications

Changing Patterns in Israel Agriculture

By Hain Halperin. Pp. 290. London: Routledge and Kegan Paul. 1957. 28*s*.

Whereas ancient Palestine was agricultural in character, the modern State of Israel is no longer wholly agrarian. Nevertheless, agriculture is not merely bound up with the national economy of that country, but is a way of life which has played an important rôle in the movement for Jewish independence and in consolidating the present regime.

In this book Prof. Halperin describes the remarkable progress of agriculture in this region during the past decade, the means by which the enormous emigrant population has been absorbed and discusses the new trends in agricultural settlement and rural sociology in relation to the economic policy of the State. He shows how, in face of great difficulties, the State succeeded in founding agriculture as a living force in the country.

Water, winds, animals and man have each played a part in various periods in the past in destroying the soil. 'The waves of the Mediterranean created sand-dunes, the winds eroded the fertile soil covering the mountain slopes. Men and goats destroyed the grasses and trees, which had previously checked the inroads of erosion, thereby increasing the havoc'. The picture is a familiar one which may be found duplicated in many countries.

The principle of State ownership of land has been accepted without question in Israel and is the basis for the establishment of various forms of co-operative land settlements. Inevitably the success of these settlements has been uneven, and many problems still remain to be solved. The task of settlement was, however, one of great magnitude and difficulty, which has been met with courage and tenacity.

Agricultural development depends on making the fullest use of all sources of water. About 60% of the territory is in the arid zone and the distribution of water from the better watered north to the coastal and southern districts is a major problem. In the past few years irrigation has been extended into many regions, but to implement fully the schemes envisaged will take some years and may prove to be beyond the financial means of the country.

The acute shortage of foreign currency makes it necessary to increase local production so as to reduce imports. Overall planning, states the author, must concentrate upon those branches of agriculture that constitute a source of animal proteins – the most expensive item in the import list – while the maintenance of export crops is also essential in order to gain foreign currency. To maintain a balance between crops for home consumption and those for export does not appear to have been achieved, although it is obviously desirable that agricultural policy should not only be stable, but also conceived on a long-term basis.

Far too little money and research have been devoted to the improvement of agriculture in the drier parts of the world. In showing what can be done in this direction this book is a valuable contribution to literature on agriculture in semi-arid regions.

D. H. GRIST

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Mekhanizatsiya Subtropicheskikh Kultur

By Sh. Ya. Kereselidze. First edition. In Russian. Pp. 325, illustrated. Glavpoligrafizdat, Tiflis, Georgia, U.S.S.R. 1957. Price not stated.

The author, a Georgian, has been associated with Russian research on mechanical harvesting of tea for many years, at first working at the State Agricultural Design Institute at Tiflis, and later as Director of the Kutaisi Agricultural Research Institute. He is thus admirably qualified to write the first Russian book on an aspect of mechanisation which has been dealt with far more thoroughly and extensively in the Soviet Union than in any of the other major tea-producing countries in the world.

The book opens with some general basic information on the tea plant and the various species and hybrids in commercial use, this being followed by a discussion of the actual scope and history of tea production in the U.S.S.R. and the climatic and agricultural factors which affect the use of machinery, *i.e.* the temperature, plantation gradients, row widths and terrace layouts.

Before an efficient harvester can be designed for any crop, detailed knowledge of the crop itself is necessary. Therefore a vast amount of work was done, measuring the number and distribution of tea shoots per unit area of bush, the leaf weights, dimensions, moisture content etc., and calculating the force required to break off the shoots at various times during the harvesting period. The results of this work are described and amplified by a tabular supplement.

On the basis of this knowledge, many cutting units of different designs were tested in the laboratory and in the plantations. After many were rejected, a unit having two staggered rows of three-stage fingers was found to be suitable, the tea shoots being broken off between the two outer fingers by the pressure of the third. Some 80 pages are devoted to the theory of the action of the fingers, the moments, forces and deformations involved, and to the results obtained from tests.

Suction is the only practicable way of collecting the severed tips, and further technical details are presented on the design, power requirement and efficiency of the fan and air ducts used to suck the shoots from the bushes into a hopper. The pneumatic system is mounted, together with the cutting unit, on a specially developed high-clearance tractor.

Machine-harvested tea was compared with that from conventional hand harvesting and adjudged to be at least its equal.

The results of strict State tests on the prototype harvester during the 1953 to 1955 seasons, the advantages and inadequacies of the machine, and analyses of the harvested tea are discussed in detail. The saving of labour brought about by the use of one harvester on 65 acres is calculated at 2,100 man-days per annum.

The work contains a brief discussion of leaf sorting and of stationary machinery developed for this purpose, and is rounded off by a bibliography of 31, mainly Russian, references.

This minutely detailed account of an attempt at mechanisation of one of the most difficult crops to harvest is of absorbing interest and, as it was a successful attempt, the account is therefore of real and permanent value. The language barrier is unfortunate, as a translated version would be invaluable for anyone concerned in tea production.

W. LINNARD

Die Insektizide

By Werner Perkow. Pp. 384, illustrated. Heidelberg: Dr. Alfred Hüthig Verlag. 1956. DM. 28, approx. 50*s*.

This is a textbook which deals with the chemistry, the application and the physiological effects of insecticides. It also deals with the related problems of the biological control of pests, the risk of the destruction of useful insects, and the danger to warm-blooded animals, arising from the use of certain chemicals. The laws regarding the handling and the use of toxic products are also considered.

Besides providing a useful introduction to the subject, this is a book which should find a place in every scientific library. There are a tremendous number of references, which provide opportunities for further study; and in the appendices there is an explanation of the technical expressions and a list of insects with their Latin equivalents, both of which will be of great assistance to the layman.

F. C. COOKE

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Agricultural Notebook

The 13th edition of 'The Agricultural Notebook' has been completely revised to bring it up to date. It provides a valuable handbook for farmers and agricultural students and, although it contains 846 pages, the size and format make it possible to carry it about as a pocket book for quick reference. There is a comprehensive index. The present edition includes a new section on farm machinery specially written by members of the staff of the N.I.A.E. and on the control of insect pests, weeds and diseases of crops by the Association of British Insecticide Manufacturers. The editor is Prof. H. Ian Moore, Principal of Seal-Hayne Agricultural College.

Published by Farmer & Stockbreeder Publications Ltd., price 40*s*.

*

Potatoes

The 'Dutch Potato Atlas', by Ir. J. A. Hogen Esch, Dr. F. E. Nijdam and Dr. H. Siebeneick, records all the characteristics of each of 46 varieties (including those in the first two supplements) which research and practical experience have proved to be important. The 46 varieties comprise all of those of which Dutch-grown seed is available. Further supplements will be issued when necessary, which it will be possible to insert in the appropriate place in the loose-leaf cover in which the book is bound. The Atlas has been published initially in Dutch, English, French and German.

A new journal, the *European Potato Journal*, which is the official publication of the European Association for Potato Research, was published for the first time in February.

A volume of the journal will consist of four issues published at irregular intervals in the same year, each containing at least 240 pages, and including articles which are original contributions on fundamental and practical potato research. The official languages of the journal are English, French and German and to each original article will be appended a summary in these languages. The subscription price is 25 Dutch guilders or the equivalent.

*

Electricity in British Farming

A 20-page illustrated brochure, published by the British Electrical Development Association, lists the publications, films and farm models which are available to aid the farmer in the application of electricity in his various operations. E.D.A. 1806 is obtainable free from the Association at 2 Savoy Hill, London, W.C.2.

*

R.A.S.E.

The *Journal of the Royal Agricultural Society of England*, Vol. 118, includes articles on 'The Value of Fertiliser Placement' and 'Advances in Rootstock Research'. The section entitled 'The Farmer's Guide to Agricultural Research in 1957' contains a special research article on 'Some Aspects of Plant Breeding' and current reviews on, among other subjects, crops and plant breeding, soils and fertilisers and farm implements and machinery. There is also a report on the R.A.S.E. farm ditching machinery competition held in 1957, with illustrations of prize-winning entries, and full information about the 1957 Royal Show, including an awards list.

*

Land Laws in New South Wales

Vol. 25, Nos. 3–4 of the 'Review of Marketing and Agricultural Economics' is Part I of an 'Outline of Closer Settlement in New South Wales' and has as its title 'The Sequence of the Land Laws, 1788–1956'. The author explains in an introduction that the aim has been to provide a 'general conspectus' or 'broad canvas' of more than 150 years of land development and to reduce a complex story to its simplicities and bare essentials. The earlier period has a background of droughts and floods, pests and diseases, but in recent years the results of scientific research have been a predominant influence in the course of settlement.

Published by the Division of Marketing and Agricultural Economics, Department of Agriculture, N.S.W., Australia.

*

Farm and Horticultural Workers

This is the title of a new, well-illustrated booklet in the 'Choice of Careers' series issued by the British Central Youth Employment Executive. The different kinds of farms and farm work are described, covering dairy, sheep, pig, poultry and arable farming and a section on horticulture describes work in market gardens, in glasshouses, nurseries and in public parks and gardens. It is written principally for those about to choose a career and for those who are advising them. Methods of training, opportunities available and wages and conditions of employment are all dealt with. This booklet is No. 86 in the series and is obtainable from H.M.S.O., price 1*s*. 9*d*.

No. 85 in the series, 'Agriculture and Horticulture: Managerial and Technical Posts', deals with training and opportunities available in the managerial side of farming, the advisory services, agricultural and horticultural research, and in commercial concerns closely connected with agriculture. For these posts training at a university or agricultural college is usually necessary. Price 1*s*. 3*d*.

Bookshop Service

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Technical Books,
308 Euston Road,
London, N.W.1.
Telephone: Euston 5911.

Other miscellaneous publications reviewed should be obtained direct from the addresses given.

Machinery and Equipment

Trench Digging and Pipe Laying

Recently over 150 yd. of tiled drain were laid at Ford's mechanised farm, Boreham, using the new Howard trench digger and pipe layer, powered by a Fordson Major tractor fitted with a Howard reduction gear unit, through which the implement obtains its power.

Front cast-iron wheels were used to counter-balance the weight of the rear trencher unit and 'Rotaped' tracks replaced the standard Fordson rear wheels, so as to give extra stability and good traction with the minimum pressure on the trench walls.

This unit enables a trench to be dug and the pipes to be laid in one operation. On this occasion the depth of trench required was 3 ft. 6 in., upgrading to 1 ft. 6 in.

A Turbo Spray Irrigation System

British Overhead Irrigation Ltd. have developed a new sprinkler head that entirely eliminates the use of springs, which rather tend to lose their tension or will break with continual use. The new 'Turbo' sprinkler head is rotated by a small water-turbine; it travels round and round at a slow steady rate, producing a fine penetrating shower, simulating the effect of natural rain. It is strongly constructed in non-corrosive metals and with minimum maintenance it should last a lifetime, as there is nothing to go wrong.

The new heads can be supplied with either high-trajectory jets for watering farm crops, pastures etc., or with low-trajectory jets for the 'under foliage' watering of orchards. They are available in several different sizes, with a variety of different size nozzles to meet all requirements and for sprinkler lines as long as 1,000 ft.

The portable mains for use with these spray heads are made in units up to 35 ft., and in all intermediate sizes from 1½ in. up to 6 in. For example, where calculations show that a 3½-in. diameter pipe is the correct size to use in a system, it is not necessary to buy a 4-in., which is normally the nearest larger size available. These intermediate sizes reduce the capital outlay and make for more efficient operation.

The couplings used to join the pipe units together, whilst being capable of instant connection by a simple lever action, remain completely watertight even after the pressure of water is released. They are flexible for use on undulating ground and are designed to protect the ends of the pipes against rough usage.

Complete sets of equipment, including pumps to operate from the p.t-o. of a tractor or pumps operated by diesel or petrol, portable mains, self-closing hydrants and other necessary items of equipment can be supplied by B.O.I.L., if a plan and particulars of requirements are sent.

Reader Service

For further information on any item of machinery or equipment reviewed in this issue please write to:

Reader Service,
WORLD CROPS,
Leonard Hill House,
Eden Street, London N.W.1,
England

The B.O.I.L. 'Turbo' sprinkler head rotates at a steady rate and produces a fine shower of artificial rain

The new Howard trencher and pipe-layer taking the first cut at the stream bank when the drainage scheme was being put in at Ford's Mechanised Farm in Essex, England

New Range of Pumps

The new range of Hill-Barnes pumps now available to British and overseas markets includes standard and self-priming centrifugal pumps and domestic water systems, capable of lifting water from 200 ft. deep wells when aided by patented ejectors.

The principal advantage claimed for the design is that the pump will prime down to 25-ft. suction lift with as little as one-third of the normal water level

in the pump body. Leakage of water through the discharge connection or suction clack valve, whilst the pump is standing idle or being transported, will not affect the self-priming characteristic.

The pumps are available in sizes from ¾-in. to 6-in. dia. hose connections, with discharges from 1,000 to 90,000 gal. per hour. They can be employed with heads up to 400 ft. Each size will handle solids up to 25% of the flow of a size up to one-quarter that of the suction connection. It is claimed by the makers that these pumps can be run for long periods dry without damage either to the pump or shaft seal. In addition, they state that they can be run against closed discharge valves without overheating.

Automatic Glasshouse Watering

The ' Solu-ply ' system of low-level automatic watering is a completely new technique. It uses 2¼-in. black lay-flat polythene tubing punched, at 5-in. spacings, with four holes of $\frac{1}{32}$ in. diameter. Black tubing is used to prevent light entering and causing the growth of algae which might block the holes.

The tubing is placed permanently between rows of tomatoes, carnations and other crops. When not in use it lies flat on the ground. When filled with water it becomes round with two rows of holes on each side. The lower holes direct the water downwards to cover the ground near the hose; the upper holes direct the water farther afield. The width of throw can be varied from 8 in. to 16 in. by the main water supply.

A Hill-Barnes self-priming centrifugal pump

' Solu-ply ' in use on transplanted sweet corn

(Below) *The ' Solu-ply ' system of low-level automatic watering in use on young tomato plants*

The holes are machine punched, thus ensuring even size and spacing of the holes. The size and spacing have been found by experience to give accurate coverage of the ground. After the hose has been turned on for a few minutes, the water spreads over the surface of the ground and a strip up to 3 ft. wide is evenly watered.

The system can be used for low-level irrigation of almost any intensive crop in beds or borders. It may also be used for winter flooding in glasshouses, for applying ' Solufeed ' liquid fertiliser, and soil sterilants, such as ' Formasan ' brand formaldehyde.

The rate at which the water is applied depends on the width of throw. Table 1 shows the output from the tube for different distances of throw.

Table 1
Water output for different widths of throw

	Throw		
	8-*in.*	12-*in.*	16-*in.*
Gal. per yd. of tube per hour ..	14	17	22

At a throw of 12 in. each side of the tube, 2 gal. a sq. yd. can be applied in approximately six minutes.

The method of planting tomatoes in double rows running the length of the house is admirably suited to watering with ' Solu-ply '. One tube is placed in each double row of tomatoes. As the maximum throw for even watering is about 16 in., wide beds, such as 4-ft. wide carnation beds, will probably need two rows of tube running parallel to give good coverage.

As already shown, the total length of ' Solu-ply ' tube which can be used at any one time depends on the output from the water supply. In practice, the length which can be run from any one feed point is limited by the loss due to friction in the tube. This friction

loss means that if the tube is laid on level ground the throw at the far end (and consequently the output) will be less than at the water supply end.

An equally important factor is the slope of the ground. With gentle slopes, it is helpful to feed the water into the higher end of the tube, as the slope then compensates to some extent for the loss by friction, and a longer tube can be used than when the ground is level. On the other hand, when feeding uphill the length which can be used is correspondingly reduced.

The hinged end rotary cutter enables the 'Baagφ' orchard mower to cut grass right up to the tree trunk

On fairly steep slopes the added effect of gravity more than compensates for the loss by friction and the throw at the bottom may be farther than at the top. In this case more even application can often be obtained by partially restricting the flow of water about halfway along the tube. This can be done very simply with a spring clothes peg.

An Orchard Mower

The 'Baagφ' orchard mower has been specially designed for cutting the grass between the fruit trees in orchards. It is claimed by the makers to be the only machine of its kind which will cut right up to and round the base of each tree trunk, as there is a movable hinged arm which draws back when it touches a tree, feels round the trunk and then moves back to its extreme position after the tree has been passed. Thus it is unnecessary to trim round the base of the fruit trees by hand. The machine can, of course, also be used for topping pastures and for cutting grass on racecourses, sports grounds and parks.

It consists of a set of belt-driven rotary cutters, spinning horizontally, which are mounted on a beam; this assembly is carried under the tractor and between the front and rear wheels. It is offered in three sizes – with four, five or six blades, with cutting lanes of 2.32 metres, 2.90 metres and 3.48 metres respectively. The unit is carried and powered by the tractor and in addition is supported by two bogie wheels. It is designed to fit the Ferguson tractor, but it can also be mounted on the Fordson Major and the David Brown tractors by means of a special fitting.

Strawberry Cultivation

In the past, inter-row work amongst strawberries with a rotary cultivator has always presented problems, for strawberry runners, when cut, have always tended to bind-up the tiller especially on long straight runs.

This difficulty has, however, now been overcome by Clifford Cultivators Ltd., who now manufacture a special strawberry conversion set for their Mk. 1 cultivator, which has a specially designed rotor with dish-shaped blades.

The new strawberry conversion set for the Clifford Mk. I cultivator

This unit is easily fitted in place of the existing tiller and ensures that all strawberry runners are cut cleanly, so eliminating binding up.

Independent Trailer Brake

Caterpillar Tractor Co. announce the introduction of an independent brake control group for use with the Caterpillar DW20 tractor. Designed for use with either wagons or scrapers, the new attachment makes it possible for the operator to engage the brakes of the trailed unit only, as it works independently of the tractor brakes. Its purpose is to serve as an anti-jack-knifing device when operating on hazardous ground.

The control group consists of a two-position hand-operated air valve and air circuit, with the hand valve mounted conveniently on the steering column. This attachment is available for field installation, or it may be installed at the factory on new machines, if required.

A New Agricultural Aircraft

The market for agricultural aircraft covers the entire world, and it is estimated that some 10,000 aircraft are now being used for aerial spraying and dusting. Experience has shown that converted types are not so efficient and that aircraft specially designed for the job are required. Auster Aircraft Ltd. therefore have produced a range of special agricultural aircraft. These range from the light 'Alpha', carrying 48 gal. of spray fluids, to the 'Agricola', capable of carrying 144 gal.; the new 'Workmaster' with its 100-gal. spray tank is intermediate. It represents a major advance in this class of aircraft,

The 'Workmaster' was specially designed by the Auster Aircraft Co. Ltd. for aerial spraying operations. It is airborne in 180 yd.

for, besides a high load capacity and improved performance, it provides a second seat behind the pilot, an important consideration for operations in remote areas.

The very low altitudes involved during aerial crop treatment – from 2–200 ft., according to conditions – demand the adoption of features for safer flying. The spray tank is now placed alongside the pilot's seat, thus protecting him in the event of accident. It is built into the fuselage and shaped to allow good visibility when flying close to the ground. There is a quick-release valve enabling the entire load to be dumped in 5 seconds. The aircraft, thus lightened, can climb steeply away. Additional safety features include a strengthened pilot's seat with chemical-resistant shoulder type harness, a thicker bird-resistant windscreen and over-size low-pressure tyres, ensuring safe taxying over rough or muddy airstrips.

The ' Workmaster ' has an abundance of power. The 180-h.p. Lycoming motor not only enables a heavy load to be carried, but leaves power to spare and increased safety margins under all conditions of flight. Light aircraft used for spraying normally operate at approx. 70 m.p.h., but the ' Workmaster ' gives a 30% increase by cruising at 90 m.p.h. This leads to a greater acreage being covered per day.

The aircraft is fitted with the new aerodynamically balanced controls, which ensure fatigue-free flying and allow the pilot to concentrate upon his primary task of applying chemicals.

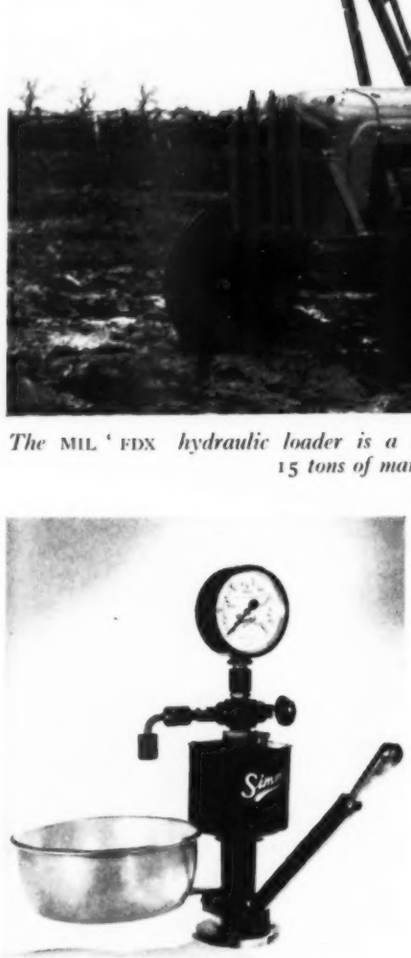
Instead of having a succession of nozzles along the wing edge, each aircraft is now fitted with two ' Micronair ' rotary atomisers and a fine mist of spray is driven into the crop by the turbulence created by the slipstream. In this way it is said to be possible to obtain effective coverage even when using as little as $\frac{1}{4}$ gal. per acre.

The Allman low-reading speedometer

Tractor Speedometer

E. Allman & Co. Ltd. have produced a special low-reading speedometer for use on the Nuffield Universal tractor. The instrument will read up to 16 m.p.h.

The MIL ' FDX *hydraulic loader is a one-man machine which can lift and load 15 tons of manure in one hour*



The Simms nozzle tester

A Hydraulic Loader

A useful attachment for the Fordson ' Dexta ' tractor is the MIL ' FDX ' hydraulic loader. Various handling devices are available for special operations–a root crop bucket, an earth bucket, a potato skip, a loading hook, a manure fork and a buckrake. The manure fork is standard, the others are extras.

The hydraulic loader is made of heavy-gauge metal tubing, giving maximum strength and rigidity with minimum weight. It is a one-man machine, which can be attached or removed in three minutes and which can be used to lift and load 15 tons of manure in one hour. The operator has a clear view and this high rate of loading can be carried out with minimum fatigue.

Nozzle Tester

Simms Motor Units Ltd. manufacture a nozzle tester for testing all types of injectors, hydraulic equipment and fittings. The pressure gauge has a dual scale graduated in lb. per sq. in. and in atmospheres, with a maximum pressure reading of 4,000 lb./sq. in. or 275 atmospheres.

Agricultural Chemicals

Foliar nutrient; preserving timber; fungicides; seed dressings; control of rats, mosquitoes, and alfalfa aphid

Mosquito Control

Malaria can still be a menace to agriculture in the tropics wherever there is no regular spraying programme. Mosquitoes breed not only in ditches, drains, ponds and swamps, but also in the smallest accumulations of water, such as in discarded bottles or tins, in the leaf axils of certain plants, in hollow bamboo stumps and even in the roof guttering of bungalows. For the effective control of these pests it is necessary to spray the surroundings of labour lines, villages and human habitations at regular intervals for a distance of at least 200 yd. It is fortunate that mosquitoes do not travel far from their breeding grounds. During the heat of the day they seek harbour in the rafters of houses and in shady vegetation.

In mosquito spraying operations it is important to obtain uniform and effective coverage by avoiding droplet deposition. This can be achieved by including a small amount of an emulsifier, 'Triton B-1956', in the formulation of the oil-based spray to ensure efficient wetting and sticking action. By reducing run-off, this will also reduce the amount of spray needed to obtain an effective 'kill'.

This additive is manufactured by Rohm and Haas.

*

Potato Blight

Potato blight is very dependent on the weather. In a dry season it causes little or no damage, but when warm, moist periods occur during the summer it spreads rapidly from plant to plant. It may then completely destroy the tops in August or even by the end of July and cause a loss in yield of two or three tons to the acre.

In the year 1845 the potato crop in Ireland was totally destroyed by this disease; one-third of the population died in the subsequent famine and 1½ million were forced to emigrate.

Today the disease can be controlled by a number of proprietary copper preparations, which are sold in a form ready for mixing with water. These are all easy to handle and are efficient fungicides. For those who are prepared to mix the sprays themselves, freshly-prepared Bordeaux or Burgundy mixture can be recommended.

A good Bordeaux mixture for potatoes is one containing 10 lb. of powdered or granular copper sulphate (bluestone) and 12½ lb. of best hydrated lime in 100 gal. of water. Burgundy mixture is prepared in the same way, but contains 12½ lb. washing soda instead of the hydrated lime.

*

Foliar Feeding

Plants have the ability to take up, translocate and synthesise nutrients from materials which have entered through their leaves. This provides a useful method of maintaining plant growth under adverse conditions. During periods of exceptionally dry weather plants are unable to take up any fertiliser from the soil; in fact, it is possible for serious damage to be done to plants, if certain chemical fertilisers are applied during periods of drought, since the soil bacteria are stifled.

Conversely, heavy rainfall (particularly in a sandy soil) can quickly leach the more soluble fertilisers from the topsoil. Young plants do not have much depth to their roots and much of the fertiliser top-dressing is carried beyond their reach and lost.

Then there are soils which are either naturally deficient in trace and minor elements, or have become so owing to the continued use of artificial fertilisers, which do not provide all these essential nutrients. These are extracted from the soil by every crop until a critical level of deficiency is reached and crop disorders become apparent. Unhealthy crops can also be the result of a deficiency caused by the fact that essential nutrients, although present in the soil, are locked up and thus are unavailable to the plants.

Finally, there is the question of the decreasing fertility of a soil, due to the exhaustion of the humic fraction, which is particularly marked in tropical soils or where supplies of farmyard manure, compost and plant residues are not available. Soil is a living complex in which plants grow in conjunction with soil organisms. Clovers, for instance, depend very largely on the action of soil bacteria.

'Naturfeed' is a complete balanced foliar nutrient for spray application. It contains the three major plant nutrients as well as the essential trace elements, but in addition it is claimed by the manufacturers, the Vigzol Oil Co. Ltd., that it builds up a 'living' soil, as it promotes the multiplication of soil bacteria and, in particular, the activity of clover and other leguminous plants. The organic content of this product is derived from seaweed.

In order to avoid scorch, it is essential to dilute the material with at least 10 gal. of water and for some crops even more water should be added, as recommended. It is possible to cut down the application cost by using this liquid fertiliser in conjunction with hormone weedkillers.

It is recommended for application to grassland, to cereals, to potatoes, to cabbage, kale and sugar-beet and also to apple trees.

*

A Rat-free World

A new method of effective rat control is announced by C. F. Gerhardt Ltd., who are manufacturers of 'Dethmor-Warfarin', a tasteless and odourless rodenticide, which is virtually harmless to man or beast or bird. It will kill rats over a period of days, quietly, painlessly and surely; they literally eat themselves to death – returning again and again; there are no convulsions, no mad dashes for water, and nothing to cause 'bait shyness'.

The manufacturers state that it is virtually harmless to humans or animals unless taken in considerable quantity over a prolonged period. The remote risk to domestic pets is reduced by using grain- or cereal-type baits, which are less attractive to most flesh-eating animals, and the use of bait boxes would be a further safety measure.

This rodenticide is a concentrate which makes 20 times its own weight of finished bait when mixed with oatmeal, rolled oats, bread crumbs, ground rice or wheat. This mixture is

placed in 8-oz. lots in the areas frequented by the rats. The baits are replenished every 14 days; consumption reaches its peak in four to seven days and then gradually tails off to nothing as the rat population is reduced. Thereafter all that is necessary is to have a few permanent bait stations to catch strays or newcomers.

Such baits are also effective against mice, but they have to be smaller and more numerous; a slightly longer baiting period will bring equally effective results against mouse colonies as against rats.

This new product was evolved, developed and tested in the Biochemistry Department of the University of Wisconsin, U.S.A., and it has already produced dramatic results in sugar stores, flour mills, warehouses, godowns and farms throughout the U.S.A., according to the makers.

*

Rapid Migration of Aphid

Since its first appearance in New Mexico's Rio Grande Valley four years ago, a new aphid with a fantastic reproduction rate and a voracious appetite for alfalfa has spread across the central U.S.A., from California to Virginia. It migrates freely from field to field; travels great distances on the wind; and even 'hitch-hikes' from State to State by car, train or aircraft. In northern climates the female aphid produces from two to five living young per day without mating. Cold winters are not a bar to survival. It is not eliminated by temperatures as low as 5°F.

The damage caused by the spotted alfalfa aphid takes several forms. Seedling plants are killed rapidly. Heavy infestations may completely destroy a young stand. Aphids feeding in a harvested field can prevent regrowth by completely covering the developing shoots.

Where sufficient alfalfa survives for cutting, the stand is often ruined by the honeydew which aphids secrete while feeding. A sooty fungus growing in this honeydew soon reduces the leaves and stems to a black, sticky mass. This is unpalatable and practically impossible to harvest with modern field cutters and balers.

California's State Department of Agriculture estimated that in 1955 the spotted alfalfa aphid caused $13 million (£5 million) damage to alfalfa crops. In 1956 the aphid cut Oklahoma's alfalfa production by 50%, a loss of $16 million (£6 million) to the growers.

So far natural predators, such as ladybird beetles, lacewing flies and syrphid flies, have not provided any dependable measure of control. At present the most effective method of control is chemically, with malathion, a product developed by the American Cyanamid Co., which offers high aphid kill, extremely low hazard to humans and animals, and a short time interval between application and harvest.

*

Seed Protection

The flea beetle, or turnip fly, first attacks the seedlings of turnips, swedes, kale, mustard, rape and other field brassicas just as they are breaking through the soil and without proper protection an entire crop may be lost.

'Gammasan' seed dressing contains gamma-BHC insecticide and the fungicide – thiram or TMTD. Used as a seed dressing, it gives protection against the flea beetle during the vital period when the seedlings are emerging and up to the first leaf stage. It also gives some protection against wireworm and the thiram that it contains provides a measure of protection against foot rots.

Many merchants now supply seed ready dressed, but seed can easily be dressed on the farm in a drum mixer or, for small quantities, by shaking the seed and the dressing together in a tin or bottle. If a heavy dressing is necessary, *e.g.* 1 oz. per lb. of seed, one dessertspoonful of paraffin added for every 4 lb. of seed will make the dressing adhere better. Such a heavy application is only applied in areas where flea beetle attack is normally very heavy; the more usual rate of application is between ¼ and ½ oz. per lb. of seed. Seed so treated will store safely for several months.

Reader Service

For further information on any item reviewed in this issue please write to:

Reader Service
WORLD CROPS,
Leonard Hill House,
Eden Street, London, N.W.1,
England

Preservation of Timber

Resinous timbers, pine in particular, are particularly subject to 'blueing', an important cause of deterioration which it is easy to avoid by appropriate chemical treatment; timber, used or stored under bad conditions, will become covered with moulds or infected with rot; and certain species of soft tropical woods yield timbers of very low value, which are practically unexportable if they are not given drastic chemical treatment within the shortest possible time after exploitation.

Insects are also included in the band of wood destroyers and from the time of cutting until timber is put into service various species, in turn, depending on the moisture content of the wood, are able to attack it.

Xylochimie offer a range of products which enable these attacks to be effectively prevented. The cryptogils-xylophenes which they market are for the treatment of green sawn timbers against wood borers, mould, blue stain and other sap stains. An illustrated brochure can be obtained through our Reader Service.

*

Fisons-Geigy Agreement

Fisons Pest Control Ltd., crop chemical division of Fisons Ltd. and the Geigy Co. Ltd., of Manchester, sole concessionaires in the U.K. of J. R. Geigy S.A., of Basle, Switzerland, have announced the conclusion of an agreement respecting agricultural and horticultural chemicals which provides for the co-ordination of all aspects of research and a fusion of marketing and distributive services in these fields.

Fisons Pest Control are associated with pioneer work in agricultural chemicals, particularly herbicides. The development of Fisons 18-15 selective weedkiller is the most recent example of their work (see WORLD CROPS, 1958, **10,** 144); J. R. Geigy S.A. are known for their many original discoveries in the insecticide field and will always be associated with the highly successful and still unique DDT products. Two of their most recent discoveries have been the insecticide diazinon and the weedkiller simazine.

The entire range of Geigy agricultural and horticultural products, apart from DDT itself, will now be marketed in the U.K. by the Fisons Pest Control organisation.

World Crop Reports

INTERNATIONAL REPORTS

Coffee

Total world production of green coffee for the 1957–58 marketing season is estimated at 50.1 million bags, compared with 45.7 million bags estimated for 1956–57; world exportable production is estimated at 41.5 million bags, while exportable production for the 1956–57 season is now estimated at 35.0 million bags.

Total production of green coffee for 1957–58 is expected to be at least as large for all producing continents as in 1956–57. Very small increases are now expected for Africa and Asia. A larger increase is expected for North America and the largest, both in volume and percentage, is estimated for South America.

In *North America* significant increases are expected in production in 1957–58 for Haiti and the Dominican Republic. The Dominican Republic is expected to have a record crop in the 1957–58 season, substantially in excess of the 1956–57 crop, which was reduced by drought. Haiti likewise is expected to produce considerably more this year.

South American production is now estimated at 30.5 million bags for 1957–58, compared with an estimate of 26.7 million bags for 1956–57.

African total production for 1957–58 is estimated at 8.7 million bags. It is reported from Uganda that recent drought will seriously affect the crop after the first quarter of 1958.

Total *Asian* production of green coffee is now estimated at 2.6 million bags, just slightly above the 1956–57 crop estimate.

Tobacco

World tobacco production dropped slightly in 1957 after increasing for many years. Production in 1957 was 8,360 million lb., 224 million lb. less than in 1956, and 126 million lb. less than in 1955.

A drop of 497 million lb. in total U.S. output, chiefly as a result of a sharp reduction in acreage, was the main factor in the decline in world production. There were also decreases in Pakistan, Japan, Italy, the Federation of Rhodesia and Nyasaland, West Germany and Hungary. However, there were increases in production in Greece, Yugoslavia, Bulgaria, India, Poland, Philippines, Burma, Canada and other countries.

Production in *North America* was 2,132 million lb., compared with 2,601 million produced in 1956. U.S. production in 1957 was 1,684 million lb., compared to 2,181 million lb. in 1956. The big drop was in flue-cured leaf, with a crop of 990 million lb. in 1957 and 1,423 million lb. in 1956. A 20% reduction in acreage in addition to a reduction of 45,000 acres placed in the Soil Bank were the main reasons for this decline. There were production increases this year of 13.5 million lb. in Cuba, about 7.5 million lb. in Mexico, 5 million lb. in Canada, and 4 million lb. in the Dominican Republic.

Production in *Western Europe* was approximately 720 million lb., an increase of 73 million lb. over 1956. The largest percentage increase (63%) in Western Europe was in Yugoslavia, with an indicated production of 110 million lb. Production in Greece also rose sharply to 227 million lb., compared with 181 million lb. in 1956.

Production in *Eastern Europe*, including the U.S.S.R., is estimated at 843 million lb., compared with the 786 million lb. for 1956. This was due chiefly to more favourable weather in 1957. The largest increases occurred in Poland and Bulgaria, with a slight decrease indicated in Hungary.

The 1957 production for *Asia* is estimated at 3,751 million lb., compared with 3,685 million lb. in 1956 and 3,527 million lb. in 1955. The greatest increases were in India, Burma, the Philippine Republic, Mainland China, Turkey and the Republic of Korea. Substantial decreases are shown for Japan and Pakistan.

Production in *South America* continued to increase, reaching 563 million lb. in 1957, compared with 542 million lb. in 1956 and 498 million lb. in 1955. There were increases in all countries, but these were particularly marked in Argentina and Brazil.

The 1957 tobacco crop in *Africa* is estimated at 337 million lb., a slight increase over 1956 and well above the crops of previous years. The sharp decline in the Federation of Rhodesia and Nyasaland was more than offset by increases in Algeria, the Union of South Africa, Morocco and other areas.

Production in 1957 rose almost 2.6 million lb. in Australia and there was a slight rise in New Zealand. The 1957 acreage in Australia rose to 13,000 acres, compared with 11,000 acres in 1956 and 9,000 acres in 1955.

Almonds

Shelled almond production in *Italy* during 1957 amounted to 47,000 short tons and was the second largest on record – exceeded only by the 55,000-ton output of 1950. It was nearly four times as large as the exceptionally small crop of 1956 and 14% above the 1950–54 average of 41,300 tons.

Italy is the world's most important source of almonds, annually accounting for nearly half of all foreign commercial production and about 40% of world commercial volume. Production of almonds in the noted Puglia area is said to be showing a trend downwards, as groves are being replaced by vineyards and market gardens. On the other hand, the number of trees in Sicily coming into bearing are reported to be increasing.

Official estimates place the 1957 *Spanish* crop, shelled basis, at a record of 33,000 short tons, which is 87% above the recently revised 1956 estimate of 17,600 tons and 26% greater than the 1950–54 average production of 26,100 tons.

Favourable growing conditions in *Portugal* during 1957 resulted in a crop of 6,200 short tons, shelled basis, a volume 2⅓ times as large as the crop of the preceding year, which was damaged by frost. The 1957 harvest is considered to be 17% above average for the period 1950–54, and in recent years was exceeded only in 1953.

REGIONAL REPORTS

Australia

Rice production in 1957–58 is expected to be well above that of 1956–57. Though acreage sown was 25% less, good yields are expected, in contrast with very low yields the preceding year.

The 1957–58 rice crop is forecast at 190 million lb. of rough rice, compared with 178.9 million lb. in 1956–57. Dry winter and spring weather per-

mitted growers to sow under ideal conditions. Stands are reported to be strong and weed-free and insect damage is considerably lighter than last year.

Australian commercial rice production will largely be confined to the Murrumbidgee and Murray irrigation areas, the usual rice areas. Production in the Humpty Doo area has been reduced because of a reorganisation within Northern Territory Rice Ltd. The area sown there was 170 acres and the crop was intended to maintain viable seeds for the future. At the new rice - growing project at Liveringa Station in Western Australia flood waters destroyed the new Fitzroy River dam, which was to control water for the project. Production in Queensland is still experimental and negligible.

Acreage sown to rice in 1957–58, therefore, is about normal and is now estimated at 40,000 acres. The 1957 acreage was 52,786 acres, which was above average because of supplementary rice acreages allowed by water-control officials to offset reductions expected in flood areas.

Nigeria

Nigeria is expected to have a record *cotton* crop of 180,000 bales (500 lb. gross) in August–July 1957–58. Growing conditions have been ideal and both grade and staple are reported to be the best in years. Production in 1956–57 was reduced by unfavourable weather to only 135,000 bales, compared with 150,000 in 1955–56. Cotton acreage for 1957–58 was estimated at 850,000 acres, compared with 750,000 in 1956–57. Cotton is often interplanted with other crops in Nigeria and annual acreage estimates may vary considerably.

Nigerian cotton is American upland type, mostly improved Allen varieties. The average staple length ranges from 1 to $1\frac{1}{16}$ in. Continuous research on plant breeding, disease and insect control, fertilisers and cultural methods is being done at Samaru.

Netherlands

Yields of arable crops for 1957 are provisionally estimated as follows:

The yield per ha. of *wheat* is 13% higher than in 1956 and 8% higher than the average for the years 1952–56. Since a larger acreage was sown with wheat in 1957, the total production was over 400,000 tons and 29% higher than in 1956.

The yield per ha. of *spring barley* is 12% higher than in 1956 and the total yield is estimated at 263,500 tons or 9% higher.

The total production of *oats* will amount to 519,000 tons, or 8% higher than in 1956, owing to a higher yield per ha. and a larger area under cultivation.

Total production of ware and feed *potatoes* is estimated at 197,366 tons, an increase of 2% over 1956. Production per ha. is estimated at 28,156 kg. per ha., which is 6% higher than the previous year. The yield of industrial potatoes per ha. is 29% higher than in 1956 and 12% higher than the average for the years 1952–56. As a result of the extension of the area under manufacturing potatoes, a total production is expected of 1,053,604 tons, which will be 47% higher than in 1956.

Kenya

Sisal production in Kenya is estimated at 94 million lb. in 1957, the third successive year of increasing production. Output was 87.4 million lb. in 1956, 83.7 million in 1955, and 75.9 million in 1954. In 1953, 83.2 million lb. were reported.

About three-quarters of the sisal production is centred in the Central and Coast Districts, where 38 of the 60 producing estates are located. Central District produced 38.3 million lb. of sisal in 1956 and Coast District produced 26.7 million lb. Next in importance was Nakuru District, with 11.3 million lb.

Dominican Republic

It is hoped that this season's sugar crop will be a record one of between 900,000 and 1 million tons.

Production of *rice* has been increasing and reached 78.2 million kg. in 1956, according to official statistics. Rice produced in the Dominican Republic is used solely for internal consumption.

The effects of the drought on the *cocoa* crop have been less than was feared, but the crop is below average.

The yield of *bananas* has been affected by the drought, particularly in the south, where irrigation has not been sufficient to offset the lack of rainfall. In the north of the country, the Grenada Co. are said to be increasing their production by contracting to local growers to cultivate bananas rather than by increasing the size of their own plantations. This method is said to be favoured by the Government.

The September and October harvests of *groundnuts* amounted to 10.2 million kg. and 2.9 million kg. respectively, a considerable increase over the corresponding periods in 1956.

England and Wales

The weather in March was variable, a mild sunny period at the beginning of the month giving way to colder weather, with snow in the north-east. This was followed by cold south-easterly winds, giving fairly dry and sunny weather with frosts over most areas. Milder weather returned in the last week of the month.

Autumn-sown *wheat* was checked by the cold winds and frost, but no serious damage was done and the plant, although backward in some parts of the country, was generally satisfactory. *Barley* was checked by frost, severely in some areas, but on the whole was recovering. *Oats* were affected by frosts and cold winds in several areas, but generally the crops were fairly satisfactory. *Rye*, although backward, was generally satisfactory. *Beans* were generally satisfactory and only slight frost damage was reported from most areas. Growth was retarded by the cold conditions.

Conditions were unfavourable in some districts for spring cultivations until the latter part of the month, when some progress was made. In many areas cultivations are in arrears, but progress has been generally satisfactory on light and medium soils. Good progress was made with sowing on the lighter soils, but weather conditions have retarded progress on the heavier lands.

Weather conditions delayed preparations for *potato* planting, but some progress was made with the planting of early varieties. Preparation of land for *sugar-beet* was progressing on lighter soils, but drilling had started in only a few areas.

Leys sown last year were very backward, with early growth burnt by frost and cold winds in many districts. Some eastern counties reported severe damage by pigeons. Other leys made very little growth. *Permanent pastures*, bare in many areas, showed little sign of growth.

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